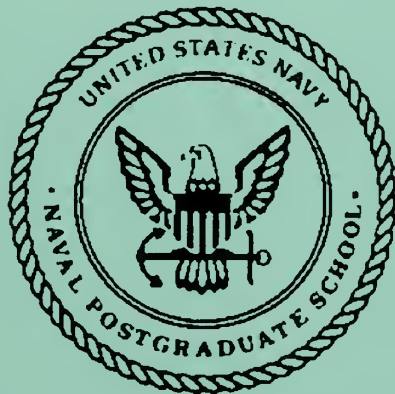


# NAVAL POSTGRADUATE SCHOOL

## Monterey, California



# THESIS

**EVALUATING CARRIER BATTLEGROUP ANTI-AIR WARFARE  
CAPABILITY  
IN A COMPUTER-AIDED EXERCISE**

by  
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September 1996

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CAPABILITY  
IN A COMPUTER-AIDED EXERCISE**

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Submitted in partial fulfillment of the  
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## ABSTRACT

One of the primary training tools available to a Unified Commander-in-Chief (CINC) for training his staff on their joint mission essential tasks (JMETLs) is a command post exercise supported by a computer simulation model, commonly referred to as a Computer Aided Exercise (CAX). Currently, little quantitative data are captured during the exercise allowing for quick post-exercise analysis of critical staff processes inherent in the CINC's exercise training objectives. The objective of this thesis is to develop an exercise analysis methodology for evaluating the execution of joint tasks during the conduct of a CAX. Specific objectives are first to demonstrate a methodology for developing quantifiable measures of effectiveness (MOEs). These MOEs must reflect the hierarchical structure of tasks given in the Universal Joint Tasks List (UJTL) as applied to three levels of war (vertical linkage), and functionality considerations between related enabling tasks (horizontal linkage). The second specific objective is to determine methods to capture task performance data within the design of the simulation. This is intended to support the exercise analysis by capturing critical decisions, assumptions, and causal factors which, in turn, lead to observed scenario outcomes. This objective involves demonstrating the methodology in an exercise conducted utilizing the Joint Theater Level Simulation (JTLS). The effort in this thesis is focused exclusively on joint tasks involving force protection, particularly air defense, of a battlegroup in the littoral region; however, the principles of the methodology are applicable to the entire spectrum of tasks in the UJTL.







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## **LIST OF ABBREVIATIONS**

AADC	Area Air Defense Coordinator
AAR	After Action Review
AAW	Anti-Air Warfare
ASCM	Anti-Ship Cruise Missile
CAP	Combat Air Patrol
CAX	Computer Aided Exercise
CG	Guided Missile Cruiser
CINC	Commander-in-Chief
CJCS	Chairman, Joint Chiefs of Staff
CVBG	Carrier Battlegroup
CVN	Aircraft Carrier, Nuclear
DCA	Defensive Counter Air
DLI	Deck Launched Interceptor
DRC	Dynamics Research Corporation
EMCON	Emission Control
ESM	Electronic Support Measures
HNS	Host Nation Support
HVU	High Value Unit
JFACC	Joint Force Air Component Commander
JFC	Joint Force Commander
JMETL	Joint Mission Essential Task List

JOA	Joint Operating Area
JTLS	Joint Theater Level Simulation
JTMD	Joint Theater Missile Defense
MEZ	Missile Engagement Zone
MOE	Measures of Effectiveness
MOP	Measures of Performance
NBC	Nuclear, Biological and Chemical
NEO	Noncombatant Evacuation Operations
OOTW	Operations Other Than War
ROE	Rules of Engagement
SAM	Surface-to-Air Missile
TM	Theater Missile
UJTL	Universal Joint Task List
WMD	Weapons of Mass Destruction
WRR	Weapons Release Range

## EXECUTIVE SUMMARY

One of the primary training tools available to a Unified Commander-in-Chief (CINC) for training his staff on their joint mission essential tasks is a command post exercise supported by a computer simulation model, commonly referred to as a Computer Aided Exercise (CAX). The primary role of the computer simulation is to present a decision environment within which the staff can be presented with realistic, stochastic results. Currently, little quantitative data are captured during the exercise allowing for quick post-exercise analysis of staff performance in tasks specified in the CINC's exercise training objectives. Objective, data-supported assessment of staff performance in joint mission essential tasks is important for two reasons. First, it helps to determine whether training resources are being used efficiently, and if the training program is achieving the desired results. Second, it helps to determine which mission essential tasks are in need of additional training.

The overall objective of this thesis is to develop an exercise analysis methodology for objectively and efficiently evaluating CINC staff performance in the execution of joint tasks during the conduct of a CAX. Specifically, this thesis focuses upon the performance of joint tasks related to the anti-air warfare (AAW) capability of a carrier battlegroup in a littoral scenario. Rather than subscribe to the current method of post-CAX analysis based upon subjective observations, this methodology presents an opportunity to quantify performance rapidly upon completion of the simulation. To accomplish this objective, four specific sub-objectives were achieved. First, the analytical tools necessary to evaluate the anti-air warfare (AAW) capability of a carrier battlegroup



located in the littoral region as modeled in an unspecified CAX were developed. Second, appropriate measures of performance (MOPs) and measures of effectiveness (MOEs) necessary to quantify staff performance were determined. Third, requirements and specifications for standardized ASCII files for capturing parameters necessary to demonstrate post-exercise analysis were developed and, finally, the methodology was tested using the Joint Theater Level Simulation (JTLS). While effort in this thesis is focused exclusively on joint tasks involving force protection (particularly air defense of a battlegroup in the littoral region), the principles of this methodology are applicable to the entire spectrum of tasks in the Universal Joint Task List (UJTL).

Fundamental to this methodology is the assumption that execution of any given task at a specified level of war is related to the execution of similar tasks at other levels of war. For instance, the UJTL strategic joint task “Provide Theater Protection” (ST 6) is related to the respective operational and tactical tasks “Provide Operational Protection” (OP 6) and “Employ Firepower” (TA 3) in the sense that the employment of firepower may be required operationally to provide Force Protection. In short, to successfully provide “Force Protection,” joint forces must, at a minimum, demonstrate proficiency on the operational level in “Operational Protection” and, on the tactical level, in the employment of firepower. This establishes the idea of vertical and horizontal linkages existing among tasks. Overall force protection is dependent upon many factors, but most notably how well the functions of intelligence, arming, fueling, employing firepower, manning, etc. are executed. After the functional and dependent relationships between

tasks are established, it is possible to determine a causal audit trail of actions leading to the success or failure of the staff's force protection policy.

Because it is not desired to create JTLS-expert staffs, the intent is to adapt the capabilities of the SIMSCRIPT-supported JTLS to the *needs* of the staff, rather than to adapt the normal activities of the staff to the requirements of JTLS. The methodology demonstrated in this thesis is designed to expedite the implementation and evaluation of staff plans and orders, while still facilitating the capture and processing of necessary data from the theater level discrete-time simulation. Once captured, the data are manipulated to produce easily understandable graphical representations of the measures collected. For example, if the force is unable to successfully defend against the enemy air threat, was this poor defense the result of poor radar performance or an inability to shoot down the threat once detected and engaged? As such, the methodology produces a quantifiable review of the performance in areas designated as training priorities by a CINC.



# I. INTRODUCTION

To lead an untrained people into war is to throw them away. *Confucius: Analacts, xiii, c. 500 B.C.* [Ref 1]

## A. BACKGROUND

The Chairman Joint Chiefs of Staff (CJCS) Memorandum of Policy 26 (MOP 26) establishes a program for carrying out the joint training responsibilities of the CJCS, the Unified Commanders-in-Chief (CINCs), and the CINC's component staffs. Through MOP 26, CJCS institutes a method for identifying joint training requirements through the review of the CINC's missions and the compilation of the Joint Mission Essential Task List (JMETL). A CINC's JMETL is intended to provide the basis for all joint training for elements of his theater, whether in the strategic, operational or tactical level.

The Universal Joint Task List (UJTL, MCM 147-93), a supplement to the Joint Training Manual (MCM 71-92), is an attempt at a comprehensive listing of all joint tasks pertaining to the Armed Forces of the United States. Though it will not be implemented until 1998, the UJTL is intended to provide for all services a common language for describing joint warfighting capabilities throughout the entire range of military operations, including operations other than war. Specifically, tasks in the UJTL are defined as they relate to the strategic (both national and theater), operational, and tactical levels of war. Each joint task at the strategic level is broken down into supporting tasks, which may in turn be further refined into enabling tasks.

One of the primary training tools available to a CINC for training his staff on their joint mission essential tasks is a command post exercise supported by a computer

simulation model. This simulation is commonly referred to as a Computer Aided Exercise (CAX). The primary role of the computer simulation is to present a decision environment within which the CINC and his staff may be presented with realistic, stochastic results. Based upon the events represented in this simulated environment, joint staffs implement plans, monitor the current situation, and further develop or alter plans as necessitated by changing requirements in the scenario.

## **B. PROBLEM STATEMENT**

The overall objective of this thesis is to develop an exercise analysis methodology for objectively and efficiently evaluating CINC staff performance in the execution of joint tasks during the conduct of a CAX. Rather than subscribe to the current method of post-CAX analysis based upon subjective observations, this methodology presents an opportunity to quantify performance rapidly upon completion of the simulation. Specifically, this methodology focuses on Strategic Task Six, Provide Theater Protection, as stated in the Universal Joint Task List. To accomplish this objective, four specific sub-objectives must be achieved:

1. Develop the analytical tools necessary to evaluate the anti-air warfare (AAW) capability of a carrier battlegroup located in the littoral region as modeled in an unspecified CAX.
2. Determine appropriate measures of performance (MOPs) and measures of effectiveness (MOEs).
3. Test the methodology using the Joint Theater Level Simulation (JTLS).
4. Develop requirements and specifications for standardized ASCII files for capturing parameters necessary to demonstrate a potential post-exercise analysis.



This research parallels similar efforts by Capt. Kerry Gordon, USMC, on Universal Joint Tasks involving firepower [Ref 2]; LT Mark Sullivan, USN, involving mobilization planning; [Ref 3] CPT Kevin Brown, USA, on tasks involving maneuver warfare; [Ref 4] CPT John Thurman, USA, on tasks involving theater force protection; [Ref 5] and Maj. Mark Cwick, USMC, on tasks involving amphibious operations. [Ref 6] Furthermore, the research builds upon that performed last year by CPT Ray Combs, USA, [Ref 7] and LT Chris Towery, USN [Ref 8]. It is recommended that these additional theses be read in conjunction with this document. Taken together, these theses represent the baseline for future efforts to develop evaluation methodology for joint staff performance.

## C. NAVAL APPLICATION

Ships, planes, tanks, and most importantly, trained soldiers, sailors, airmen and marines, and the leadership to make the force work in joint and combined operations cannot be created in a few days or months. *General Colin L. Powell* [Ref 9]

The United States military's contribution to diplomacy is often carried out through power projection. Successful power projection requires that naval forces locate and operate in regions other than strictly blue water, open ocean zones. As a result, strategic requirements often dictate that naval High Value Units (HVUs), such as aircraft carriers (CVNs) and guided missile cruisers (CGs), station themselves well within the effective weapons range of enemy land based forces. For naval assets, force protection while stationed in a littoral region is a difficult proposition for several reasons.

First, while naval surface forces are positioned in a “near land/overland” environment (the region where naval sensors extend from sea to an area “overland”), individual surface platforms’ organic active sensors experience a unique phenomenon which degrades their performance as a result of mixed returns from sea and land backgrounds. In short, because naval air and surface radars are designed to operate predominantly over maritime environments, their performance is degraded when placed in proximity to the shoreline. Accordingly, individual asset positioning and specific sensor employment while stationed in the littoral can significantly influence the overall sensor performance of the battlegroup.

Second, with the decreased flight range associated with littoral targets and technological advances - particularly in weapons speed and flight profile - comes decreased reaction time. To ensure success against the variety and complexity of weapon systems constituting the enemy air threat (aircraft and missiles), the joint force requires thorough preparation prior to the initiation of actual conflict. Offensive action by enemy aerospace assets must be countered by a strategy based upon unity of effort by all forces, employing all joint air defense assets in a manner which minimizes overall reaction time and maximizes the collective defensive capability of the force.

In sum, the basically reactive nature of air warfare to the enemy’s choice of strategy dictates that consistently successful air defense cannot be adequately improvised in extremis. Effective prior training at all levels of war, and constant surveillance of both the enemy’s assets and the joint force’s air superiority region must be maintained to ensure the timely response of air defense.



## D. THESIS STRUCTURE

The next chapter outlines the joint training process employed by the military services as directed and agreed upon by the CJCS. Chapter III describes the current joint AAW hierarchy and explains the issues of interest and primary concerns to joint task force commanders (JFCs). Also in Chapter III, the difficulties of naval AAW in the littoral are examined, and issues relating to naval force protection in the littoral are outlined. Chapter IV details a methodology for developing quantifiable measures of effectiveness necessary for the evaluation of carrier battlegroup (CVBG) AAW in the CAX and the relationships between strategic, operational and tactical tasks associated with Force Protection. This particular methodology focuses on describing relationships existing between tasks in terms of the critical issues underlying their accomplishment. For example, where naval warfare is defined more appropriately by *power warfare* more than *maneuver warfare*, the critical issues defining accomplishment are based upon enemy kills, not necessarily movement or logistics, though they certainly contribute. [Ref 10] Chapter V demonstrates a methodology for extracting data from a Joint Theater Level Simulation which can be used in a post-exercise analysis/after action review (AAR). Chapter VI discusses conclusions and provides recommendations for further refinements and study.



## II. JOINT TRAINING PROCESS

Maintaining high readiness of our forces is a prerequisite to deterring aggression and responding to crises. Today we are placing increased emphasis on joint readiness strengthening joint doctrine and education, developing joint readiness measures, and improving joint and coalition training. [Ref 11: p. iii]

United States military operations range over a wide spectrum of conflict, with operations other than war (OOTW) recently added to the more traditional combat roles. Accordingly, and as a result of the country's unique position as the dominant world power, the United States military must remain strong and capable at all times. However, in a military era characterized predominantly by budget cuts and force reductions, large scale joint training availabilities are, at best, infrequent. As a result, the overall *quality* of military training must increase to fill the experience gap created by reduced opportunities for "hands-on" training. Combined military forces are developing and implementing new joint doctrine with an emphasis on symbiotically harnessing the strengths of the services, while effectively reducing weaknesses. Therefore a premium is placed on the efficient implementation of strategy without a compromise in effectiveness.

This new effort will provide true joint functionality over air, land, sea, space, and special operations environments, using tactical C4I nets for distributed training, and will be based on joint doctrine, tactics, techniques and procedures. As a direct result of the force multiplier effect experienced through joint operations, multi-service coordination is now the standard by which all tactical and operational success will be measured. However, decreasing defense budgets drive the reality that future joint training requirements will be met increasingly by modeling and simulations. With that in mind, the

critical issue for CINCs becomes the method of maximizing training benefits in a new, budget constrained environment.

## **A. DEVELOPMENT OF THE UNIVERSAL JOINT TASK LIST (UJTL)**

As to the military side of the war, there is one lesson which stands out above all others. This is that modern warfare can be effectively conducted only by the close and effective integration of the three military arms, which make their primary contribution to the military power of the nation on the ground, at sea, and from the air. *Fleet Admiral Ernest J. King, USN* [Ref 12]

The current version of the UJTL was developed by Dynamics Research Corporation (DRC) under the direction of the Joint Exercise and Training Division of the Joint Staff's J-7 Directorate. To create a thorough document, the Joint Staff, CINCs, Services, and other concerned agencies coordinated the design input of over 120 organizations. [Ref 13] As written, the UJTL, which has the flavor of the U.S. Army Blueprint of the Battlefield, provides a common structure for describing joint warfighting capabilities in terms of tasks, conditions and standards for all services. With the UJTL, each branch of the service is able to focus training on tasks described in a common doctrinal language which have not only unique service applications, but real-time joint applications as well. Furthermore, capabilities within the three levels of war depicted in the UJTL describe the entire range of military operations, including operations other than war (OOTW) and Low Intensity Conflict (LIC). [Ref 14]

One aspect of DRC's overall project included the creation of the joint task list, joint conditions list, and associated task measures. The joint task list, as displayed in Figure 1, consists of all joint, supporting, and enabling tasks at each of the three levels of war which formally specify the required capabilities of the nation's armed forces. The

joint conditions list contains various physical, political, social, and military states that describe all anticipated operational environments. Additionally, DRC developed computer software to aid in the use of the UJTL. In the current Joint Training Computerized Analysis (JoinT-CATS) software, which allows users to sort the joint, enabling and supporting tasks according to topics of interest, DRC provides several measures

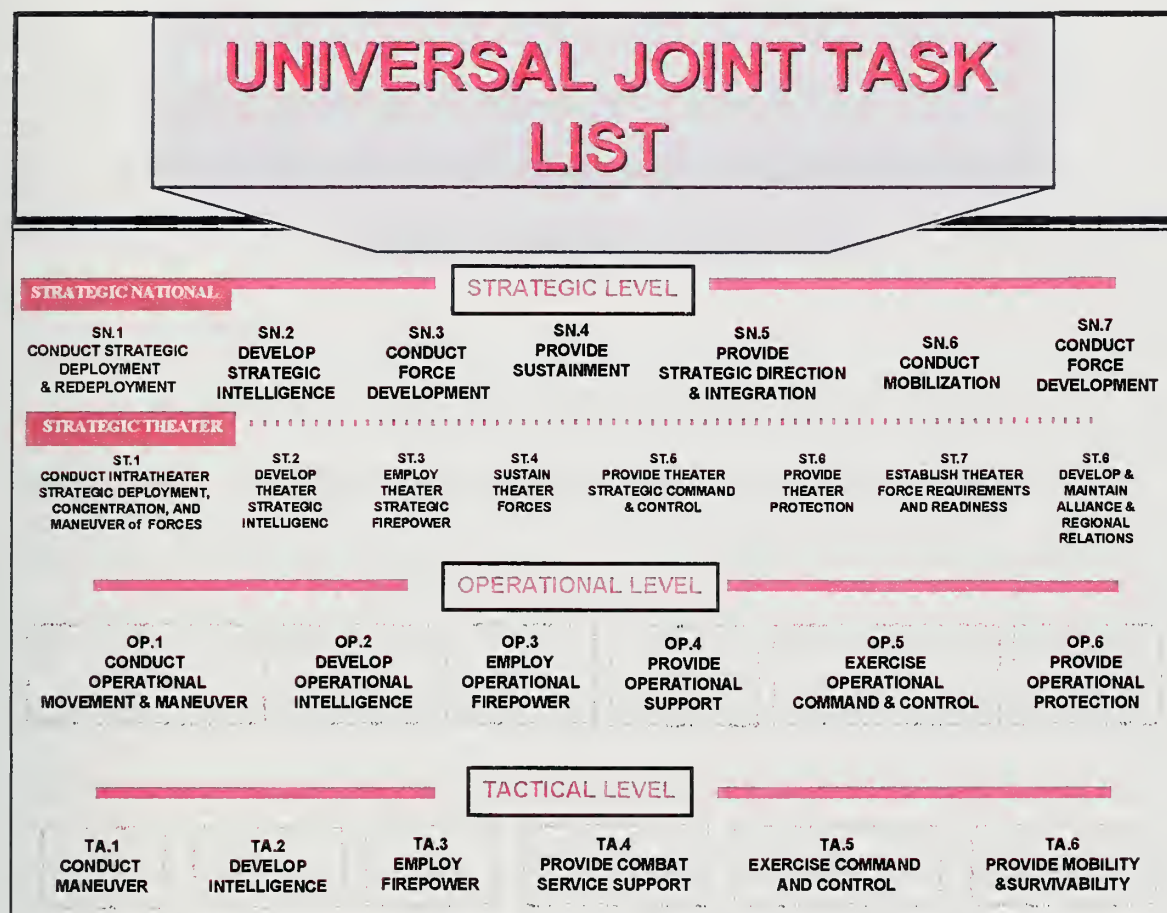


Figure 1. Universal Joint Task List.

of effectiveness (MOEs). These MOEs are parameters describing task performance that, when specified in terms of conditions and a minimum acceptable level of performance, are a statement of the task's standard. The joint measures list provides performance criteria at





the task level to assist commanders in quantitatively assessing staff performance and determining those tasks in greatest need of additional training. [Ref 14]

## **B. JOINT TRAINING PROGRAM**

It is believed that leaders and subordinates of all ranks, at all levels, do most of their learning during training, thus making “realistic, demanding, and objectively measured training and exercises a must.” [Ref 9 ]

The military’s joint training program encompasses all aspects of joint training within the DOD. Fundamental to the program are the following two tenants:

1. Base training on mission requirements, emphasizing warfighting as the highest training priority, and
2. Joint training must conform to, and exercise, joint doctrine. [Ref 13]

Military missions supporting the national military strategy are assigned to CINCs, after which a mission analysis is conducted to determine required command-level capabilities. [Ref 11] Essential capabilities are reflected in the CINC’s Joint Mission Essential Task List (JMETL) which identifies a specific CINC’s priorities while providing the collective requirements base for all joint training in his theater. Joint Mission Essential Tasks must be referenced in terms of the UJTL. [Ref 14] Requirements for training are based on the CINC’s JMETL, along with applicable joint doctrine/joint tactics, techniques and procedures (JTTP). Requirements are then analyzed in terms of appropriate mission conditions, necessary standards, command level responsibility and training resources available, in order to generate the CINC’s Joint Training Plan and subsequent exercise schedule. [Ref 14] Developing a training program for scheduling an exercise without a JMETL linkage, regardless of the scale of the proposed training, may result in the



unfocused and often wasteful expenditure of scarce resources and should therefore be avoided.

The purpose of the joint training program is to establish the relationship between the joint training system and the joint doctrine system -- ultimately to provide an improved fighting force for the CINC. The focus of the program is on clearly defining joint training requirements in order to more efficiently allocate scarce training and operational resources and to improve the ways and means of conducting joint training in the ultimate interest of improving readiness. [Ref 14]

The selection and documentation of tasks, conditions and standards and the concept of employment of forces are functions of the combatant commands, their operational joint force commanders, and the functional joint force component commanders. Theater commanders, who assess training, are encouraged to communicate their training requirements to subordinate commanders through the JMETL process. While the UJTL in its entirety is a document almost exclusively for the CINC, combatant commanders may train independently or, with other forces, specifically to their CINC's JMETL. However, below the theater level, ultimate training responsibility remains with the individual unit commanders.

### **C. JOINT THEATER LEVEL SIMULATION (JTLS)**

*...Train and exercise today's forces, on today's equipment, with today's doctrine... General Shalikashvili, CJCS [Ref 12]*

The Joint Theater Level Simulation is an interactive, multisided, joint (air, land, sea and special operations) and combined (coalition warfare) constructive simulation

model which is used for both operational planning and training support. JTLS, a computer-based wargaming system, strives to model conflict (combat operations, pre-combat, and post-combat) at the operational level with tactical fidelity. JTLS supports explicit coalition warfare functions: dynamic coalition development, designation of political or military factions, setting of Rules of Engagement (ROE), executing Host-Nation Support (HNS) agreements, conducting Noncombatant Evacuation Operations (NEO) and operational conflict. A modularized software architecture allows distributed operations across multiple hardware platforms, witnessed by the ability to run JTLS on “open systems,” including SUN, HP and DEC workstations. The latest release of JTLS, version 2.0, contains several significant improvements over the previous release (version 1.0), including an integrated graphics user interface, a message processor, on-line player manual, a combat events program and an information management terminal.

The program is separated into six operational modules: main, logistics, air, ground, naval and intelligence. Included in functional changes to the previous release are psyops, in which the affected units suffer decreased effectiveness; civil affairs activity; improved intelligence representation, including “real world” reports in MTF format; casualty and remains processing, in which battle casualties and remains accumulate until evacuated; and a shared air picture, in which coalition sides receive air tracks only if they have either no track or an incorrect identification. The “windows-style” graphical user interface provides a significant improvement over version 1.0, which was largely dependent upon familiarity with the Model Interface Program (MIP) order input functions and a voluminous user manual. The data-driven version 2.0 features on-line hypertext user help



menus and color-defined graphics to denote features such as force identification and terrain features.



### III. JOINT THEATER AAW OPERATIONS

To conquer the command of the air means victory; to be beaten in the air means defeat. Giulio Douhet: *The Command of the Air*, 1921 [Ref 1]

#### A. JOINT AIR OPERATIONS

Due to the complexities of conducting joint air operations in support of varying warfighting and OOTW missions, joint air operations must be exercised under conditions that best replicate the operating environment in order to ensure success in times of conflict. In the past, the implementation of joint air doctrine, particularly coordinating large air operations from Joint Force Air Component Commander (JFACC) afloat, who is responsible to the Joint Force Commander for coordinating the air operations of the joint force, had significant capability limitations. [Ref 15] As a result of these past difficulties, joint commanders now carefully define the theater air conditions for optimum command and control of joint air operations and exercise them as soon and often as feasible prior to actual employment. A coordinated and integrated air defense system under a single commander is essential to successful area operations, whether at sea or over land. In order to ensure consistent success, air defense forces must be organized, equipped, trained and, when possible, positioned and alerted prior to hostilities. It is essential that compatible Army, Navy/Marine, and Air Force electronic coordination and control means, operationally connected, are established and exercised prior to the operation of joint air defense forces within a theater of war. Coordination of effort and unity of action, to include close coordination with sea-based and adjacent air defense commanders, is imperative for successful air defense operations.

Joint doctrine defines air defense as “all measures designed to nullify or reduce the effectiveness of the attack by hostile aircraft or guided missiles after they are airborne” and *active* air defense as “direct defensive action taken to destroy or reduce the effectiveness of an enemy air attack.” [Ref 16] Accordingly, air defense includes such measures as the use of aircraft, antiaircraft artillery, electronic countermeasures, and surface-to-air guided missiles in the accomplishment of the mission. Similarly, *theater* air defense applies to the identification, integration, and employment of forces supported by other theater and national capabilities to detect, identify, locate, track, minimize the effects of and/or destroy enemy air assets within the theater. [Ref 17]

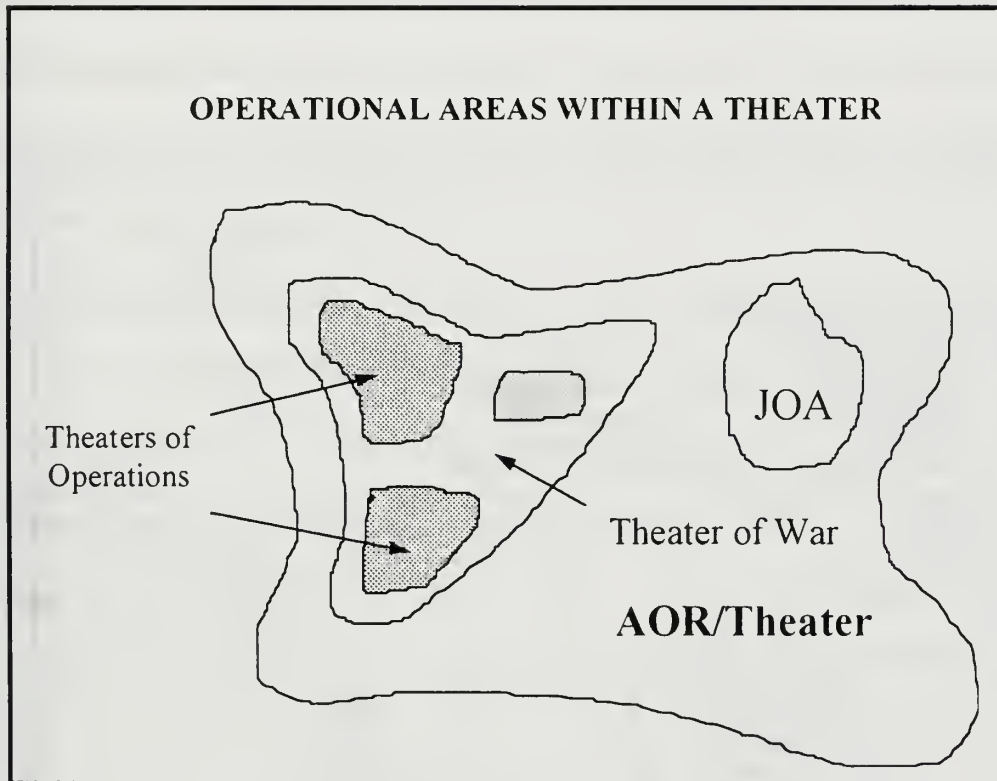
Within a theater of operations, geographic features and time and distance factors relative to the threat will affect the balance of effort required to successfully conduct AAW operations. The type of terrain in the vicinity of sensors will influence the employment and siting of AAW systems both on land and at sea. Climate and weather may also be factors affecting the conduct of attack and defense operations. The peculiarities of missile ranges, neutral country overflight restrictions, expected attack direction, missile chemical or biological warhead dispersant, location of population centers, location of units on the ground and ships at sea, communications systems and connectivity requirements are all significant planning considerations for the most efficient use of AAW assets in a theater.

Figure 2 demonstrates the operational areas within a theater. [Ref 18] Within the AOR in Figure 2, the CINC has designated a theater of war with two subordinate theaters of operations. The CINC has also established a JOA within which a JTF will operate to



handle a situation outside the theater of war. JOAs could also be established within the theater of war or theater of operations. Despite the numerous locations for operating forces within a CINC's theater, a major underlying premise of successful AAW is that active defense operations should be centrally coordinated and decentrally executed.

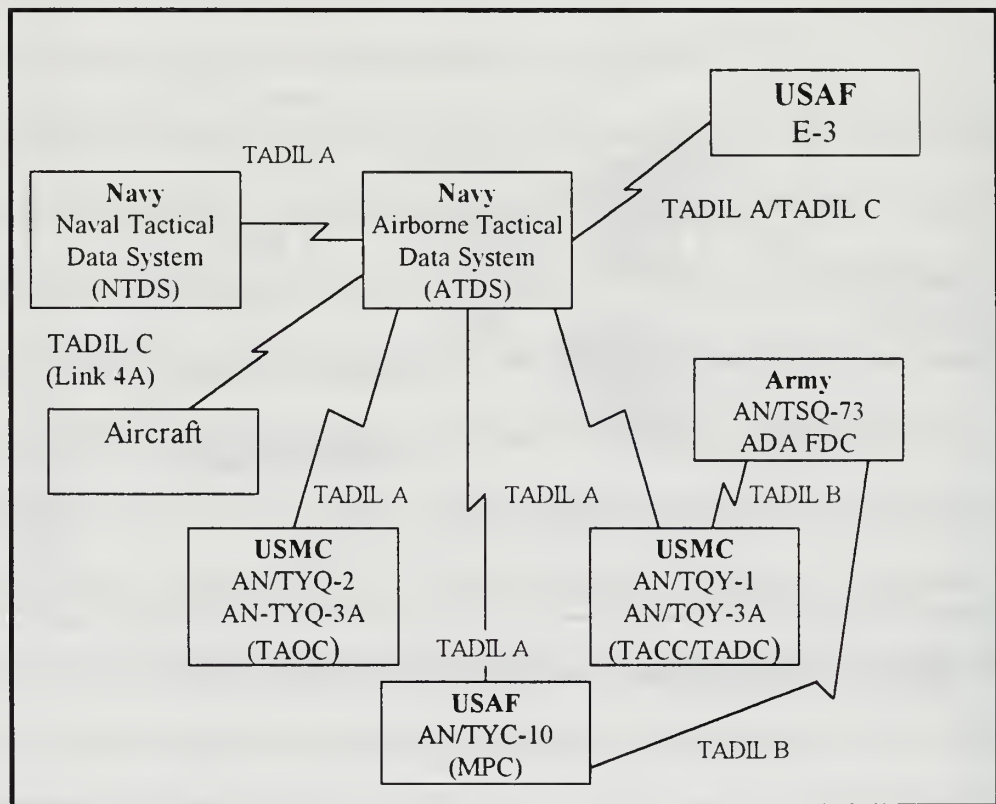
[Ref 17]



**Figure 2. A Combatant Commander's AOR/Theater. [Ref 18]**

Two or more forces operating jointly in a theater must be provided the means of conducting compatible information exchange. The ability to exchange information allows each individual force to perform at a higher level of effectiveness than can be attained by forces acting with no information exchange. Figure 3 displays the joint information exchange link from the naval airborne perspective. [Ref 19] By ensuring the effective use

of information links between the services, a JFACC is able to ensure maximum efficiency, effectiveness, responsiveness, appropriateness and simplicity, consistent with the tasks and functions being accomplished. [Ref 20] Furthermore, the radar footprint covered by the combined naval, Air Force, Army and Marine air radar systems is far superior to any of the services operating independently. Note that this particular joint connectivity is centered upon naval airborne systems such as E-2Cs, but still includes ground, naval and airborne systems.

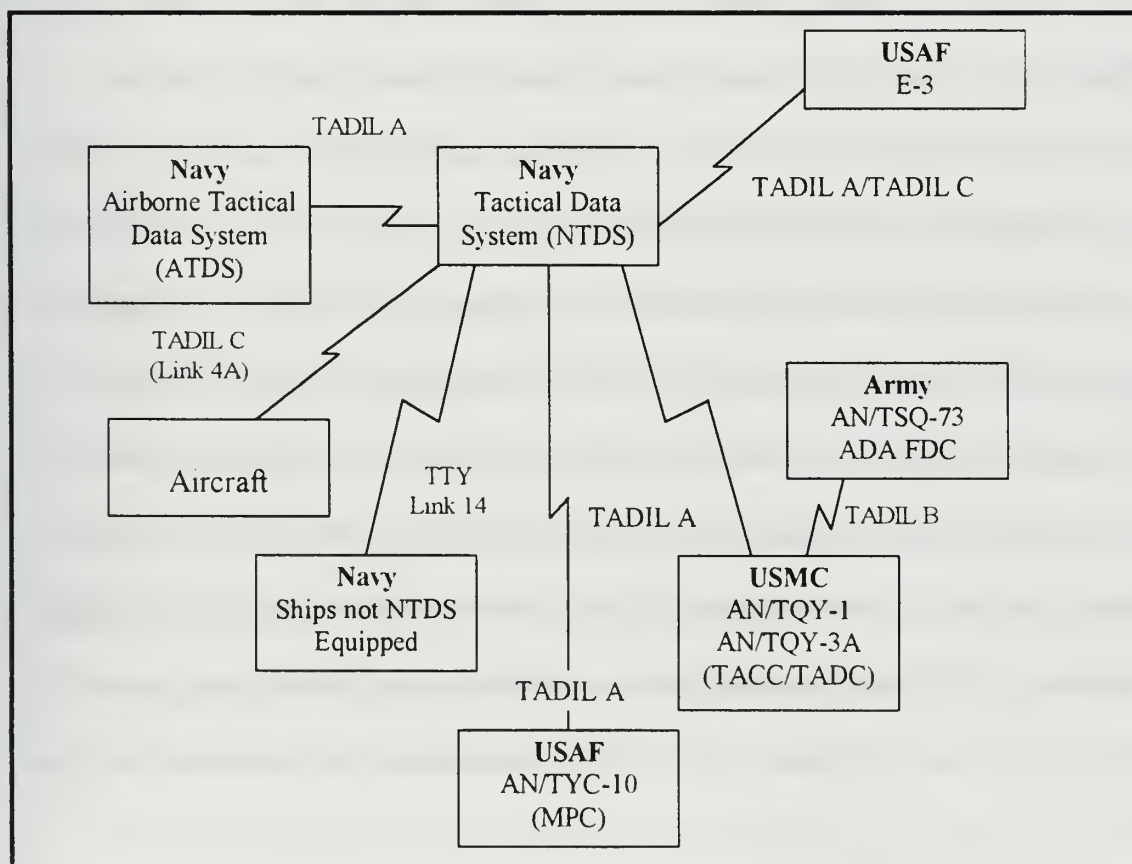


**Figure 3. Navy Airborne Tactical System Joint Connectivities. [Ref 19]**

At the joint level, the JFC may designate a joint force air component commander (JFACC). The JFACC is responsible to the JFC for coordinating and integrating the air

operations of the joint force. Depending on the nature of the joint operations, a naval commander may serve in a variety of roles. While the operation is primarily maritime, he may serve as the JFC or as a JFACC and shift that command ashore if the operation shifts landward in accordance with the JFC's concept of operations.

If the JFACC is a naval component commander, he will deploy on a surface vessel best suited for the communications, information and weapons capability required of him. However, though he may initially be afloat, his joint tactical links are still capable of encompassing ground, air and naval resources. Figure 4 displays a typical maritime JFACC joint tactical system connectivity.



**Figure 4. Navy Tactical Data Systems Joint Connectivities. [Ref 19]**

The JFC normally assigns overall responsibility for theater/AOR air defense, to include active defense, to the Area Air Defense Coordinator (AADC). The AADC assists the JFC in determining missions, communications priorities, and Rules of Engagement (ROE) for active defense forces, based on assessment and prioritization of forces, critical assets and population centers. Active defense forces are under the operational control of their individual service component commanders who employ their forces under the weapons control procedures and measures established by the AADC and approved by the JFC. The AADC is responsible to the JFC for coordinating and integrating the complete air defense effort within the entire joint force. The successful conduct of theater air defense requires the integrated operation of all available air defense weapon systems of all components in the theater. Because this may require immediate action, authority to integrate air defense forces and operations in overseas land areas will normally be delegated in advance to the AADC. [Ref 17]

Specific responsibilities of the AADC include ensuring, through the organization and application of appropriate procedures within the framework of other JFC air and surface operations, that the optimum effectiveness is realized from each of the various weapon systems used for active air defense. Additionally, the AADC will ensure that no unnecessary restrictions are placed upon the employment of their weapons. If successfully employed, the AADC will prevent duplication of effort and minimize the possibility of fratricide through the coordination of the AAW assets of all service forces within the theater.

A combination of passive defense, active defense and attack operations, all fully integrated and coordinated by a robust and efficient C4I architecture, is required to meet the stringent performance requirements demanded of joint theater AAW. Such a mix must provide for the survivability of combat forces, minimize the impact on friendly combat operations, create uncertainty in enemy planning, and deter or deny the effective use of aircraft and theater missiles by the enemy against a joint force.

## **B. THEATER AIR DEFENSE**

Cease firing, but if any enemy planes appear, shoot them down in a friendly fashion. *Fleet Admiral William F. Halsey, 1945* [Ref 1]

The term “theater missile defense” applies to the identification, integration and employment of forces supported by other theater and national capabilities to detect, identify, locate, track, minimize the effects of and/or destroy enemy missiles or their launchers. [Ref 17] Understanding this, Joint Theater Missile Defense (JTMD) systems and procedures must be adaptable for joint or multinational operations in any contingency. For example, in addition to standard warfighting situations, other operations such as humanitarian assistance or noncombatant evacuation operations may be threatened by hostile forces that have a theater or cruise missile capability. The term “theater missile” in this context applies to ballistic missiles, cruise missiles and air-to-surface missiles whose targets are within a given theater of operation.

Potential adversaries possessing theater missiles (TMs) pose a threat to U.S. security interests and forward deployed forces. The proliferation of TMs and advances in missile and associated technologies, coupled with the pursuit of nuclear, biological and



chemical (NBC) capabilities, can provide our enemies with potentially decisive attack capabilities, which may include the use of weapons of mass destruction (WMD), against friendly targets. [Ref 17]

Attacking aircraft in the littoral region poses a difficult detection problem, as their flight profile often takes them over terrain features at low altitude which hinder optimum radar performance. Accordingly, theater air defense can be difficult for a maritime JFACC. Similarly, cruise missiles can be air, land or sea-launched and normally fly to their target at low altitude, thus creating a difficult acquisition problem. Often they follow an unpredictable trajectory that makes it difficult to predict their exact impact point. The mobility of cruise missile launch platforms, the small launch signature of the missiles and their reduced radar cross section also complicate anti-cruise missile operations. Stealth technologies have also been incorporated into cruise missiles, making them an even more challenging target. A robust combination of friendly active defense and attack operations is required to defeat the cruise missile threat. [Ref 17]

Because JTMD is inherently a joint mission, joint force components, supporting CINCs, and multinational force TMD capabilities must be integrated toward the common objective of neutralizing or destroying the enemy's TM capability. It has been proven that effort expended in the active defense of cruise and ballistic missile prior to launch is more successful in the overall defense against the threat. [Ref 21] This must be integrated into and in support of the JFC's overall concept of the operation and campaign objectives.



## C. LITTORAL AAW

Warfare of primary contemporary interest is littoral warfare. Missiles launched from sea to shore and shore to sea will create a tactical environment of unparalleled tactical complexity, insofar as land-sea-air interaction is concerned. *CAPT Wayne Hughes, USN (Ret.)* [Ref 10]

The littoral area contains two parts. First is the seaward area from the open ocean to the shore, which must be controlled in order to support operations ashore. Second is the landward area inland from the shore that can be supported and defended directly from the sea. Regardless of which of the two parts is being examined, there will be significant radar and visual clutter which will complicate the surface and air picture for all involved. Because of the tactical implications associated with controlling the littoral region, the vicinity of the beach will be a hotly contested region early in a joint operation. Controlled littorals often offer the best positions from which to begin, sustain and support joint operations, especially in operational areas with poor infrastructure for supporting operations ashore. [Ref 18]

Active defense must consist of defense-in-depth against all classes of aircraft and missiles, including ballistic and cruise missiles. When destruction of the missile launch platform prior to launch is not possible or successful, missiles should be engaged by all means available throughout their entire flight profile. Defense-in-depth, while compressed in the littoral, provides multiple opportunities to negate the missile threat with differing capabilities, increases the probability of kill, and prohibits the enemy from being able to easily counter the defensive systems with a single technique. Well-rehearsed AAW defense plans and preparations allow forces in a developed theater to transition swiftly across the range of military operations. [Ref 17]

Sea-based airpower and sea-launched land combat power are formidable tools that JFCs can use to gain and maintain initiative at the onset of a littoral campaign. Naval forces operating in littoral areas can dominate coastal areas to mass forces rapidly and generate high intensity offensive power at times and in locations required by JFCs. The relative freedom of action of naval platforms enables JFCs to position his assets where they can readily strike opponents. The presence of naval forces, if made known, can pose a threat that the enemy cannot ignore. [Ref 18] Even when joint forces are firmly established ashore, littoral operations provide JFCs with excellent opportunities to achieve leverage over the enemy by operational maneuver from the sea. An aggressive enemy, knowing this, may integrate aircraft and missiles against a CVBG that is vulnerable in the littoral. To defend against this, active defense operations must be integrated within the theater air defense system.

Air, land and sea-launched cruise missiles, to include land attack and antiship missiles, continue to proliferate and grow in sophistication. Allied nations and deployed U.S. forces will be vulnerable to missile attack from many developing nations whose cruise missile stocks may be neither large nor technologically advanced. Missile-equipped nations may not need to use large numbers of missiles to cause dramatic political change in a region, because the mere threat or subsequent use of even a few weapons may be sufficient to achieve a regional goal. Recall the extensive damage inflicted on USS PRINCETON (CG 59), and the associated media coverage, when it struck a mine – considered primitive by today’s standards – in the Persian Gulf. Obviously, cruise missiles pose a serious threat to maritime operations in joint littoral warfare.

## D. NAVAL FORCE PROTECTION

Under all circumstances, a decisive naval superiority is to be considered a fundamental principle, and the basis upon which all hope of success must ultimately depend. *General George Washington* [Ref 12]

To aid in the assessment of a CINC staff's ability to successfully employ force protection of the joint forces' naval component, particularly while stationed in a littoral region, this thesis provides the methodology which facilitates objective after action reviews (AARs) at the completion of a CAX; in this case, a JTLS-supported exercise. Using the data formulation explained in detail in Chapters IV and V, this methodology can be modified easily to provide force protection AARs for any component force in the theater; though this thesis is focused on force protection, specifically the AAW capability, of naval assets in the littoral region.

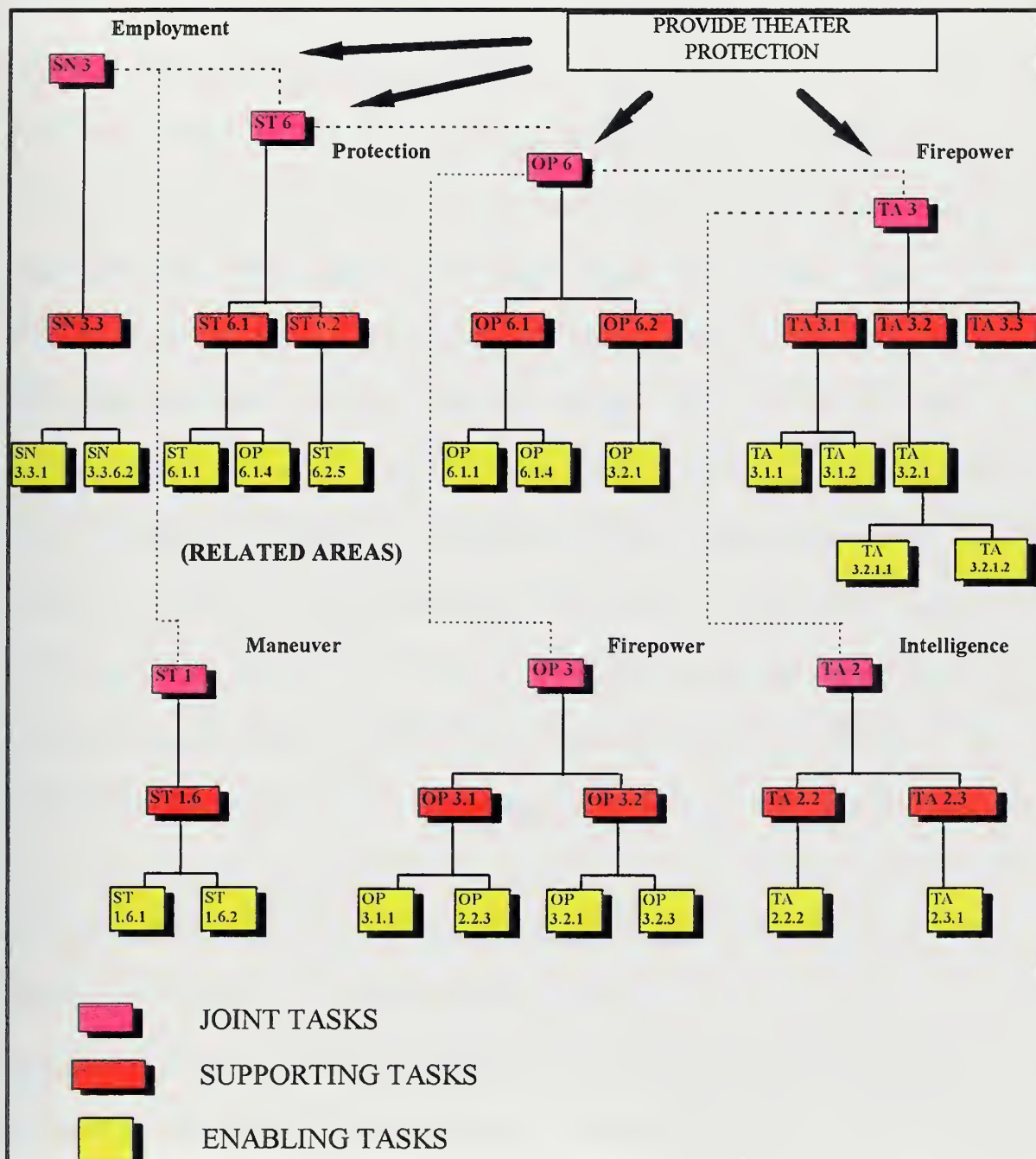
Primarily, the naval component of a joint force is tasked with providing sea-based air defense and a sea-based means for coordinating control for defense against air attack. Because of the wealth of unique assets that comprises a naval battlegroup, the naval component is also capable of providing, upon request, augmentation for air defenses ashore. Additionally, the naval surface force is responsible for maintaining liaison with appropriate air defense commanders ashore in order to prevent mutual interference should air attacks on any part of the joint force occur. In the event of an amphibious landing, naval assets will provide continuous air defense of their own forces at sea as well as air defense of the landing force. Throughout the conduct of the amphibious operation, naval forces, employing organic means and any special air defense augmentation forces which

may be requested or required for such operations, will ensure that air superiority is gained and maintained.

Despite the near land/overland radar performance anomaly previously discussed in Chapter I, sensor degradation does not relieve the joint task force's naval component of the responsibility for force protection, nor should it influence the decisions of the joint commander with respect to the naval capabilities of his force. By applying the methodology proposed in this thesis to objective post-CAX debriefs, the operational chain of command – from the CINC and component commanders to their individual staffs – can quantify strengths and weaknesses of the force protection provided by and for its naval assets throughout the course of the CAX.



distinguished by task number. Figure 5 depicts the task relationships between Force Protection tasks, as referenced in the current UJTL. One digit numbers correspond to



**Figure 5. Joint Tasks Schematic.**

strategic joint tasks, while two, three and four digit numbers correspond to supporting, enabling, and refined enabling tasks, respectively.





## IV. MOE DEVELOPMENT

This chapter presents a methodology for developing quantifiable measures of effectiveness for assessing air defense functions as described in terms of the appropriate Universal Joint Tasks. Fundamental to the methodology is the assumption that execution of any given task at a specified level of war is related to the execution of similar tasks at other levels of war. For instance, the UJTL strategic joint task “Provide Theater Protection” (ST 6) is related to the respective operational and tactical tasks “Provide Operational Protection” (OP 6) and “Employ Firepower” (TA 3) in the sense that the employment of firepower may be required operationally to provide Force Protection. In short, to successfully provide “Force Protection,” joint forces must, at a minimum, demonstrate proficiency on the operational level in “Operational Protection” and, on the tactical level, in the employment of firepower. This establishes the idea of vertical and horizontal linkages existing among tasks. Vertical linkages not only describe the relationships between similar tasks across respective levels of war, but also between joint, supporting, and enabling tasks within a given level of war. Similarly, horizontal linkages pertain to the dependent relationships between tasks describing a specific function or component with those tasks describing another. For example, overall force protection is dependent upon many factors, but most notably how well the functions of intelligence, arming, fueling, employing firepower, manning, etc. are executed. Following a similar reasoning, the functional area pertaining to the employment of firepower is

dependent upon the components field services, coordination of arms, ammunition and equipment and training. [Ref 7]

Staff activities, as described by various tasks, become compartmentalized across components and functions as the size of the staff increases. In analysis, it is necessary to reflect the dynamics of vertical and horizontal linkage as a matter of aggregation and in the interest of maintaining the appropriate level of abstraction. After the functional and dependent relationships between tasks are established, it is possible to determine a causal audit trail of actions leading to the success or failure of the staff's force protection policy.

Specific steps of the methodology include structuring the schematic of related joint tasks, developing a primary functional template, relating issues to quantifiable performance data requirements, determining measures of both performance (MOPs) and effectiveness (MOEs), and manipulating output data from simulation runs.

## **A. JOINT TASKS SCHEMATIC**

The navy under Porter was all it could be during the entire campaign [which]...could not have been made at all without such assistance. The most perfect harmony reigned between the two arms of the service. *General U.S. Grant, Memoirs* [Ref 12]

Within the UJTL, tasks are broken down in accordance with the three levels of war (strategic, operational and tactical). The first step in this methodology is the development of a joint task schematic that depicts the vertical and horizontal linkages discussed above as they specifically apply to Force Protection. Hierarchical relationships regarding respective levels of war are illustrated by the relative vertical position at each task level. Relationships between joint, supporting, enabling, and refined tasks are further

## **B. FUNCTIONAL TEMPLATES**

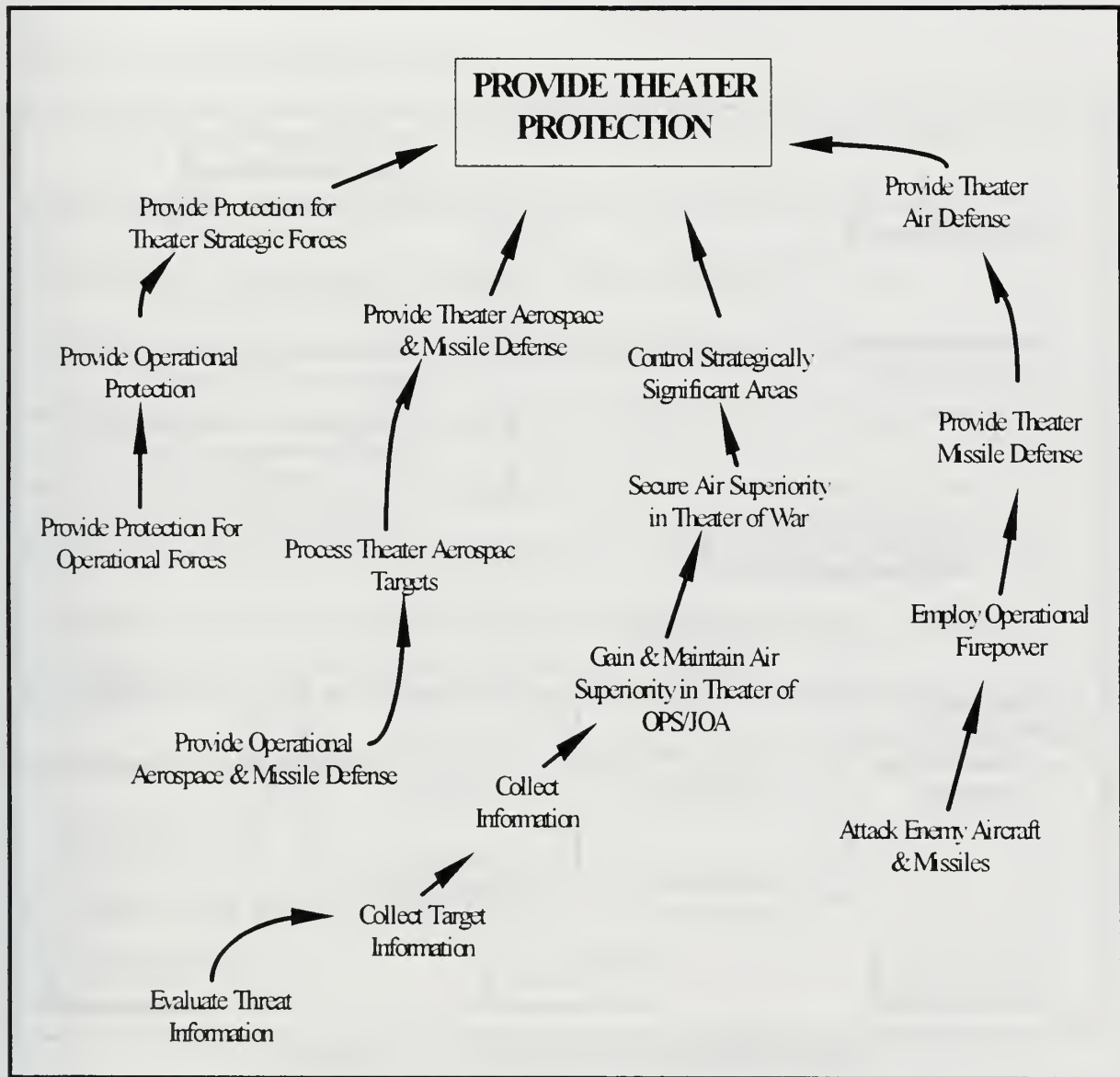
Functional templates are tools used to illustrate the precise relationships among tasks within a single functional area, such as Force Protection. Emphasis is on depicting the task-to-task linkage between the levels of war from the tactical to the strategic. In addition, components comprising the given functional areas are emphasized. The template is constructed by first considering the basic layout for a functional area as represented in the task schematic previously described. This highlights the hierarchical relationship existing between tasks within a given level of war. Next, relationships between related enabling tasks across different levels of war are determined by analyzing the scope of each task as defined in the UJTL and their interaction with other tasks. Formulation of the functional template supports the methodology by providing a complete overview of the span of sub issues (related components) and the levels at which they are resolved for each functional area. The functional template for the provision of theater protection is shown in Figure 6. [Ref 7]

## **C. DATA REQUIREMENTS (DENDRITIC)**

The purpose of the dendritic is to refine task requirements to the point where data explicative of performance can be gathered. The dendritic is formed by focusing on the overall intent of related joint tasks across levels of war and determining a question whose data-supported answer will define the intent. This question represents the overall issue



under investigation and its answer represents a data requirement. Similarly, corresponding functional areas form critical subordinate issues that generally reflect the level at which measures of effectiveness (MOEs) are developed. Specific task requirements within

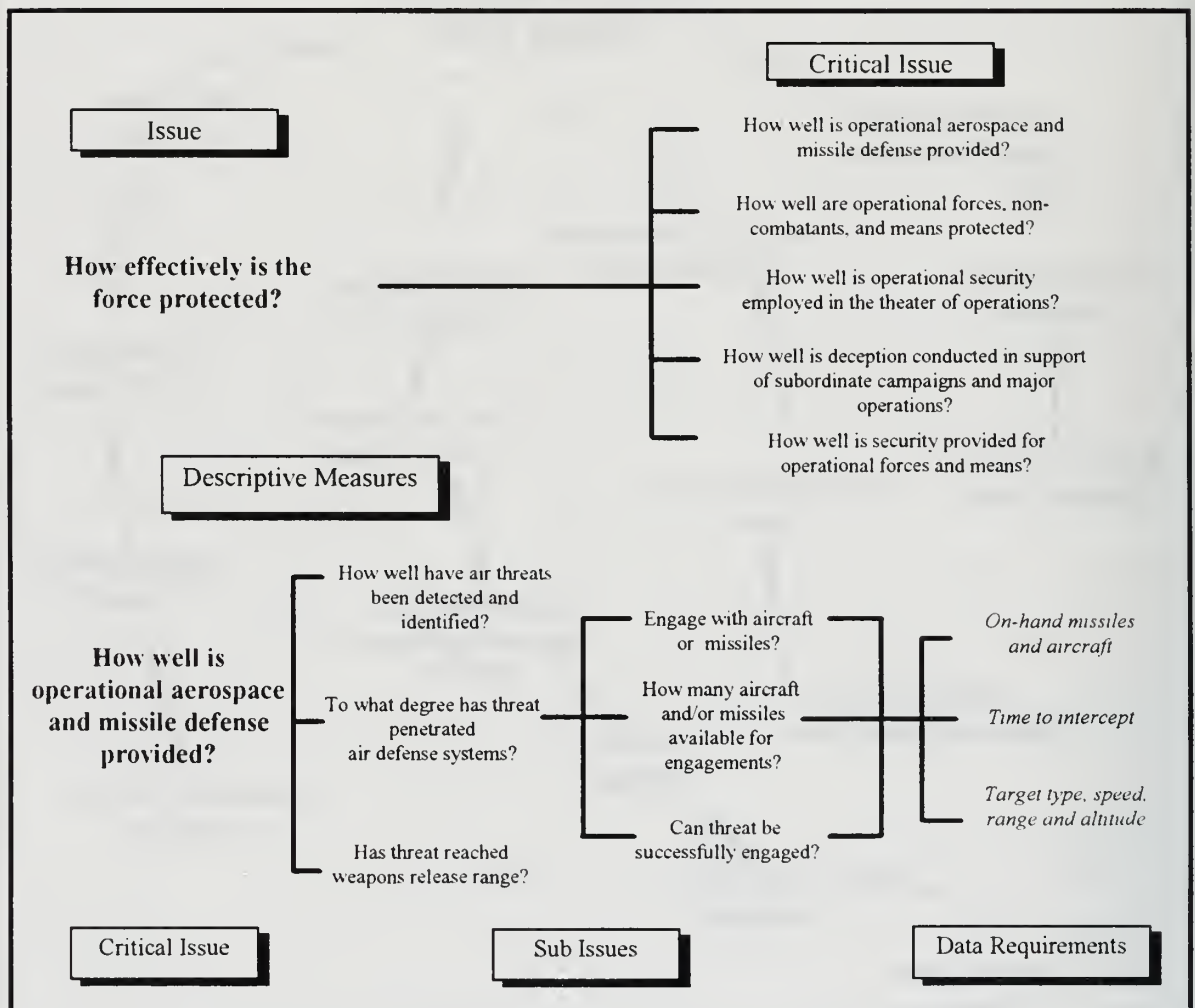


**Figure 6. Functional Template of Protection Tasks.**

each of the functional areas serve to formulate another level of sub issues that may determine underlying measures of performance (MOPs). Continued refinement of task



requirements into more specific and lower levels of aggregation ultimately leads to the point where data can be gathered with ease from the output files of a CAX. [Ref 7] For example, a partial dendritic addressing force protection, one critical issue and potential data requirements is illustrated in Figure 7.



**Figure 7. Partial Dendritic For Force Protection.**

Data requirements are assumed to be unconstrained by physical mechanisms (data base size, processing times, model resolution, etc.). Furthermore, they may be objective or subjective. Objective data refer to those directly measurable or capturable within the



context of the computer simulation's output file. Subjective data include non-measurable or non-quantifiable factors that may stand alone or serve to help qualify observed results. While subjective data from pundits currently define AARs following a CAX, the methodology contained in this thesis provides a purely objective review based on precise data retrieved directly from the model.

In the specific case when an enemy threat is airborne, the ensuing "detect to engage" scenario flowchart, as depicted in Figure 8, provides a series of data requirements as they apply to a functional template on the tactical level. By capturing data at each appropriate juncture of the flow chart, the naval component's ability to provide anti-air warfare (AAW) can be objectively analyzed upon completion of the CAX. More importantly, the extent to which the measures are applied is nearly limitless, given the scope of the data supplied by the output from the flow chart. While the capture of *all* of the data is not feasible due to prohibitive file sizes, a CINC will specifically narrow down the focus of the training exercise to enable an analyst to capture data files of a reasonable size.

## **D. MOP AND MOE DEVELOPMENT**

Each issue in the dendritic and flow chart can be classified as supporting the development of measures of effectiveness, measures of performance, or data collection. MOPs and MOEs represent an aggregation of supporting data at levels of issues where meaningful conclusions can be made. They are derived by rolling collected results

backwards through the dendritic to the point where they can be combined to address specific issues. In this manner, it is possible not only to determine the “end result” of a

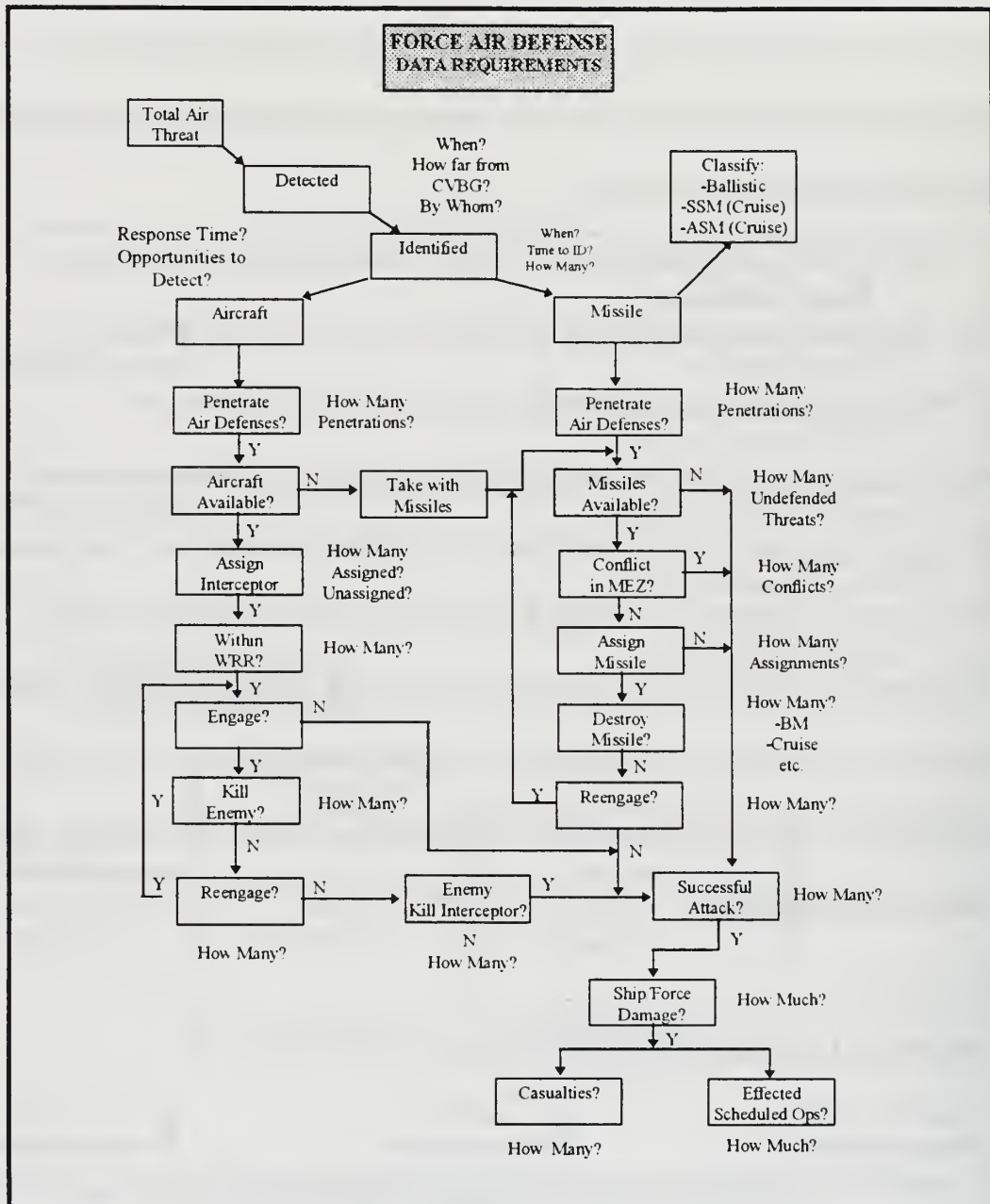


Figure 8. Data Requirements Flow Chart For Detect-To-Engage Sequence.

theater level simulation, but also the reasons for that specific outcome. For example, if the force is unable to successfully defend against the enemy air threat, was this poor defense

the result of poor radar performance or an inability to shoot down the threat once detected and engaged? A discussion of potential measures developed through application of the methodology for evaluating AAW strength follows. Definitions and terms used in the discussion are given in Table 1. [Ref 7]

Term	Definition
$ACFT_i$	hostile acft killed by CVBG AAW assets
$MISSILE_j$	hostile missiles killed by CVBG AAW assets
$TOTACFT_i$	sum of hostile acft flying against CVBG
$TOTMISSILES_j$	sum of hostile missiles flying against CVBG
$RANGE_i$	range of intercept for hostile acft engagement
$DET(t)$	time of detection of hostile acft by CVBG sensors
$CLASS_i(t)$	time of identification of hostile acft by CVBG sensors
$DETECTION_i$	binary variable; 1 if acft is detected, 0 if not detected
$ENGAGEMENT_i$	binary variable; 1 if acft is engaged, 0 if not engaged
$FACTOR_s$	surface ship AAW capability factor
$STRENGTH_s(t)$	overall strength of specific CVBG asset at time, $t$
$i$	hostile acft type (F-1, FISHBED J, Tu-16, P-3C, Mig-27D)
$j$	hostile missile type (SS-N-22, SS-N-19, HARPOON, etc.)
$s$	friendly ship type (CG, CVN, DD, FFG, etc.)
$t$	time

Table 1. MOP Term Definitions.

1. AAW Kill Performance.

Potential measures of performance for several critical issues of battlegroup AAW performance are described below.

a. AAW performance against aircraft.

What percent of the attacking enemy aircraft are destroyed?

$$\frac{\sum_i ACFT_i}{\sum_i TOTACFT_i} \tag{1}$$

In this scenario, no decoy aircraft were used. Effectively all airborne aircraft were carrying ordnance and were targeting the CVBG. This measure is critical to the CVBG's performance because the failure to negate the enemy air threat directly results in attacks against the naval forces in the form of both aircraft and missiles.

**b. AAW performance against missiles.**

What percent of the attacking enemy missiles are destroyed?

$$\frac{\sum_j MISSILE_j}{\sum_j TOTMISSILE_j} \quad (2)$$

Similar to the potential danger of the aircraft threat, an inability to destroy missiles in flight results in potential damage to the forces in theater.

**c. Overall CVBG AAW performance.**

What percent of the attacking airborne enemy threat is destroyed?

$$\frac{\sum_i ACFT_i + \sum_j MISSILE_j}{\sum_i TOTACFT_i + \sum_j TOTMISSILE_j} \quad (3)$$

This measure is simply an aggregation of both aircraft and missile kill performance, but it serves as an adequate indicator of overall threat kill performance.

**2. Engagement Range.**

At what range is the enemy aircraft typically engaged?

$$\frac{\sum_i RANGE_i}{\sum_i ENGAGEMENT_i} \quad (4)$$

This measure is useful for several reasons, but primarily because it provides insight into the success or failure of the CVBG's defense-in-depth process. Defense-in-depth provides for engagements by long range weapons (CAP aircraft) initially, followed by medium range weapons (Surface-to-Air Missile (SAMs)), then by short range weapons (Basic Point Defense Missile System (BPDMS)) and finally the Phalanx close-in-weapon systems to cover the entire range of the flight profile to a HVU. This layered defense approach provides the maximum number of potential weapons on the threat during the course of its flight, maximizes the overall kill probability and reduces the likelihood of the enemy countering all defensive systems with a single weapon system. Ideally, the enemy aircraft will be destroyed at the minimum of either the identification or effective weapons range.

### 3. Threat Identification.

What is the average time required to correctly identify the threat aircraft?

$$\frac{\sum_i CLASS_i(t) - DET_i(t)}{\sum_i DETECTION_i} \quad (5)$$

Without timely identification performance, a force cannot successfully engage an enemy threat. The rapid detection and classification of enemy air threats is particularly critical in the littoral, where response times may be measured in seconds.



#### 4. CVBG AAW Strength.

The product of each unit's strength and the unit's AAW capability factor yields the battlegroup's cumulative AAW strength as a function of time. The AAW strength factors used for the analysis in this thesis are provided in Appendix A. Note that the CVBG strength will vary for different missions (AAW, ASW, ASUW, etc.). Though this is not a stand-alone measure for AAW performance, it can provide the causal audit trail of events leading to destruction of CVBG HVUs. For example, should a primary AAW asset be completely destroyed, the overall AAW capability of the battlegroup will be severely diminished and the subsequent destruction of additional assets will be more likely. A sample output from the strength file is provided in Appendix B.

$$\sum_s STRENGTH(t)_s * FACTOR_s \quad (6)$$

#### E. SUMMARY

The role of a commander and his staff while planning a training exercise is to formulate the issues that coincide with specific training objectives for the exercise. The role of the analyst is to develop measures of performance and effectiveness and determine data requirements to assist in causal analysis of significant events observed during the simulation. In this case, the causal analysis will provide insight into the specific reasons why the CVBG was vulnerable during the conduct of the CAX or, similarly, why it was particularly efficient in its AAW performance. The methodology presented proposes



developing MOEs by aligning task descriptions with inherent issues and refining these to the point where specific data requirements are established. The examples presented above demonstrate that, given adequate analysis of the issues essential to successful task accomplishment, development of required measures becomes relatively straightforward.

[Ref 7]

Additionally, with the demonstration of the methodology comes a secondary goal of this thesis. Once the method whereby the formulation and extraction of MOEs and data is made clear, it is expected that the thesis will inspire critical thinking by readers who will envision similar applications in other CAXs, in other functional areas, in other missions, etc. The ability to *quantitatively*, vice subjectively, evaluate staff and asset performance at the completion of a CAX is a monumental improvement over the current, predominantly subjective and statistically bankrupt, system.

While this thesis focuses primarily on the kill performance of the CVBG, there are many more parameters available for the study in the AAW performance of a battlegroup. Perhaps future analysis in this area would include kill efficiency by examining the number of missiles fired *per* kill, or the singular effect of CAP aircraft on AAW performance as contrasted by the effect of SAMs. These are but a few of the potential MOEs available from the output of the flowchart given in Figure 8. Other interesting information could support the efficiency of point defense systems (Phalanx, BPDMS) as modeled in the simulation. Using this methodology, once a CINC determines a specific area for evaluation, his analysts can provide the data-supported evaluation.



## V. JTLS APPLICATION

In no other profession are the penalties for employing untrained personnel so appalling or so irrevocable as in the military. *General Douglas MacArthur, 1933* [Ref 1]

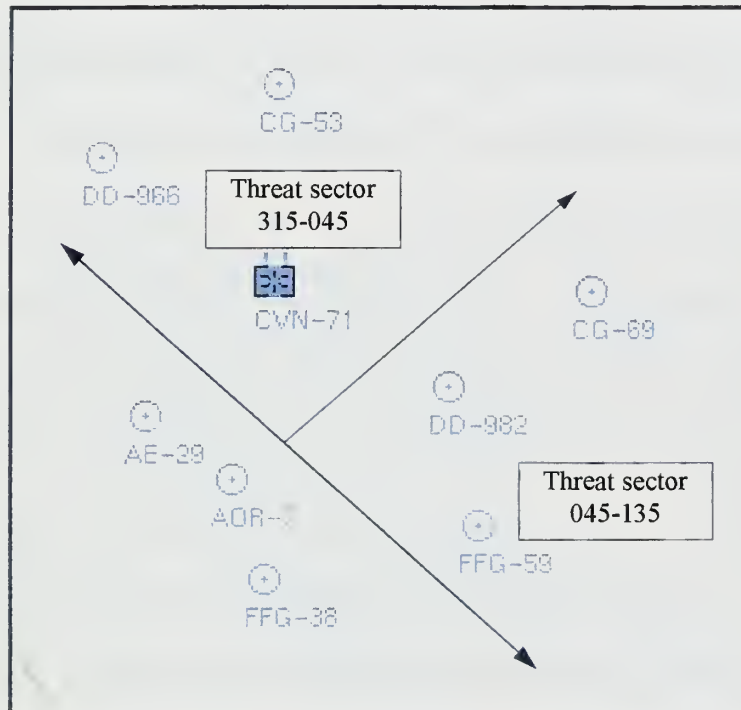
The focus of this chapter is the demonstration of MOE data extraction from actual Joint Theater Level Simulation runs. This extraction implies reliance on information and procedures inherent in the model, as well as the computer code necessary to generate the required output. However, in this case, emphasis is placed on prior determination of the desired MOPs and keeping the data extraction from the simulation as transparent as possible to the normal activities of the staff under evaluation. Because it is not desired to create JTLS-expert staffs, the intent is to adapt the capabilities of the SIMSCRIPT-supported JTLS to the *needs* of the staff, rather than to adapt the normal activities of the staff to the requirements of JTLS. The methodology demonstrated in this thesis is designed to expedite the implementation and evaluation of staff plans and orders, while still facilitating the capture and processing of necessary data from the theater level discrete-time simulation. Once captured, the data are manipulated to produce easily understandable graphical representations of the measures collected. As such, the methodology produces a quantifiable review of the performance in areas designated as training priorities by a CINC.

### A. SCENARIO DESCRIPTION

Closely following recent military history, a Southwest Asian theater of operations was chosen to demonstrate the data extraction methodology. However, far from true to



current events, some liberties were taken to facilitate the initiation of conflict. A carrier battlegroup, including a nuclear carrier (CVN), two Aegis cruisers (CGs) and other supporting elements, is steaming in the littoral waters in the vicinity of the Saudi-Kuwaiti border, as seen in Figure 9. The Iraqis are concentrating on the ground war effort currently raging on the Kuwaiti soil with the Gulf Cooperation Council and have devoted



**Figure 9. CVBG Stationing Assignments in the Threat Sector.**

the full force of their air assets to achieving air superiority over Kuwait. Accordingly, the CVBG is on alert along a threat sector from 315T to 135T, which includes the most likely avenues of attack from the Iranian air assets at the disposal of the current military leader. The CVBG surface asset and CAP stationing is designed to optimize AAW capability along the expected threat sector. The surface assets are positioned so as to roughly split





the sector responsibility between the two Aegis cruisers and the supporting assets.

Known air bases exist on the coast at Bushehr, and inland at Shiraz – each with aircraft well within their combat radius and capable of inflicting serious damage on the battlegroup.

Additionally, known missile sites exist on Kharg Island and several Iranian naval vessels are deployed from Bushehr, armed with anti-ship cruise missiles, that are within weapons release range (WRR). The CVBG is in the Gulf to provide support, power projection and air cover for a planned amphibious landing scheduled to take place in the near future and to assist in gaining and maintaining air superiority during the accompanying ground war maneuvers. There are three combat air patrol (CAP) stations active and the carrier air wing is in “Alert Five” – aircraft on the deck of the carrier are prepared to launch within five minutes – for potential air activity from the enemy. At the commencement of the exercise, the Iranians are already declared “hostile” in a situation which allows the engagement of all contacts not classified as “friendly.”

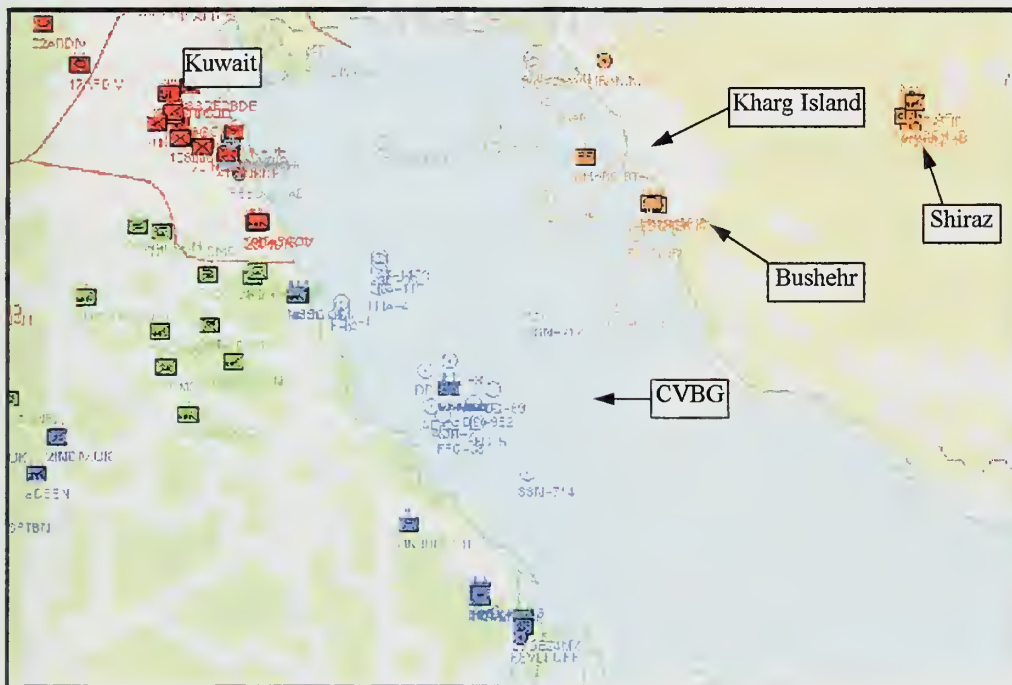
Two attack strategies were implemented by the Iranians against the Blue (U.S.) forces, with different simulations devoted to test the results of each. The file outputs and data manipulation from the different scenario runs illustrate the value of the proposed methodology. The first of the two runs represented a *heavy*, or saturation, raid against the carrier battlegroup, during which the enemy forces expect to completely saturate the U.S. naval forces’ AAW capability through sheer numbers and the timely coordination of both air and cruise missile attacks.



The second scenario, dubbed the *light* run, represented a reasonable enemy air threat over time, but was clearly distinguished from the focused and devastatingly coordinated attack in the heavy run. Figure 10 shows the Southwest Asian Theater of operations, with all forces from all sides displayed.

### 1. Heavy Scenario.

To demonstrate the saturation of the CVBG's AAW capability, the underlying premise of the *heavy* run is a well coordinated force concentration of aircraft and capable



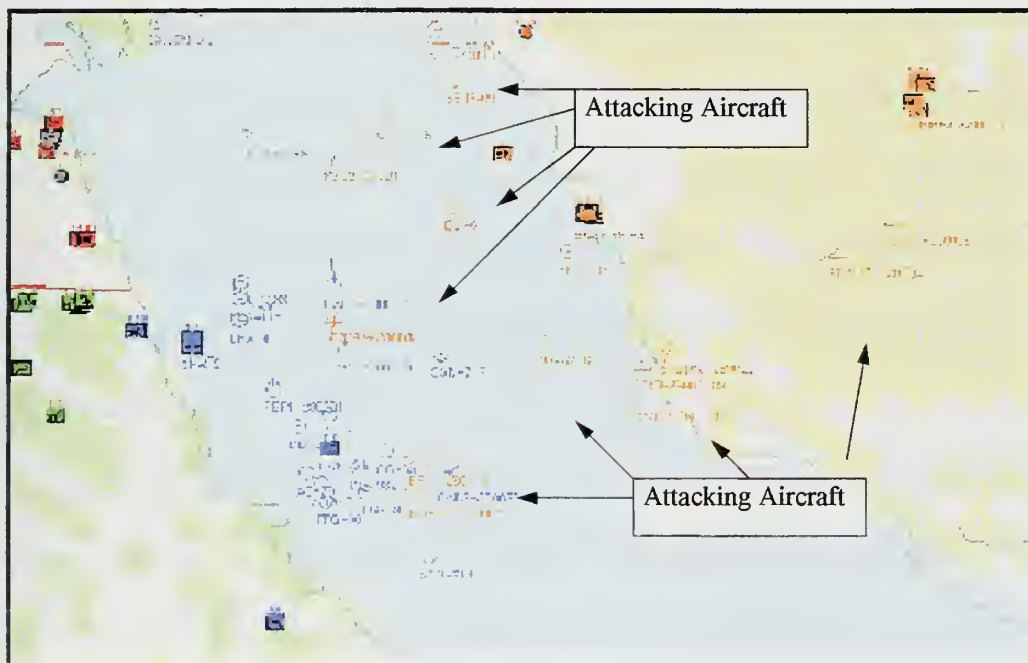
**Figure 10. Overview of Southwest Asian Theater Scenario.**

cruise missile assets against the battlegroup in a manner necessary to maximize the damage to the U.S. fleet. While the enemy aircraft represent neither a numerically nor technologically advanced force, the coordination of air strikes with an intelligently



conceived and sustained cruise missile attack plan provides a thought-provoking threat scenario for future tactical discussion. The conflict is initiated by the attack on two of the three CAP stations by enemy surface vessels who are successful in shooting down the CAP aircraft. At the same time that the aircraft are engaged, the CVN and CGs are targeted by cruise missiles from both ship and shore based platforms. The carrier sustains damage from cruise missiles which hinders her ability to launch and recover aircraft, thereby thwarting the U.S. effort to maintain fighter aircraft in the medium and long range AAW arena. Without the “forward eyes” that are normally provided by CAP aircraft, the Blue forces are blind with the exception of their organic radar sensors, which are degraded in proximity to land, as previously mentioned.

Figure 11 provides a snapshot of the coordinated enemy air assets attacking the



**Figure 11. Heavy Run Scenario Action.**

CVBG. Repeated waves of aircraft from Bushehr and Shiraz coordinate their missile





launches so that the arrival of Anti-Ship Cruise Missiles (ASCMs) is simultaneous with the arrival of shore based missiles, which are successful in damaging not only the carrier, but also completely destroying both cruisers. Though the simulation ends at this point, it is safe to assume that the remaining non-AAW assets would soon fall prey to the attacking missile forces if the scenario were continued.

## **2. Light Scenario.**

To demonstrate a “typical” Persian Gulf scenario, a scenario is developed in which the Blue forces encounter a variety of random enemy aircraft over time. In this scenario, the enemy raids are designed to test the reaction and resolve of the U.S. forces more than to carry out a saturation attack. Over the course of four hours, the enemy engages the battlegroup with aircraft, air and surface launched cruise missiles, bombs and SCUD missiles. The ability to respond to the threat is largely tied to the quality and timing of the target intelligence that is available and to the ability of the CAP aircraft to repel incoming enemy air prior to the release of their weapons. Once again the value of the horizontal and vertical linkages portrayed by tasks in the UJTL is determined in terms of force protection tasks.

In this scenario, a premium is placed on the ability of the carrier to launch Deck Launched Interceptors (DLI, known as Defensive Counter Air, DCA, in joint verbiage). While the *heavy* scenario was initiated with the shoot down of the CAP aircraft and the resulting loss of naval long range AAW, this scenario shows the ability of the CAP to deter the launch of ASCMs from enemy aircraft while engaged by CAP. Upon detection

of enemy air raids, either CAP or DCA are launched to intercept and engage the raid if possible, prior to their weapons launch. The quantifiable details of the scenario will be discussed in length in section B, Post Processing, but the effect of “shooting the archer, not the arrows,” meaning killing enemy aircraft prior to the release of their missiles, is dramatic - as witnessed by the relatively minimal damage sustained by the CVBG in this scenario relative to the previous saturation scenario.

## **B. POST PROCESSING**

Routines for capturing values required for post exercise analysis were developed and incorporated into the JTLS code by Rolands and Associates, Inc. The output files were saved in ASCII format, allowing users to import them into Excel® spreadsheets for further sorting and analysis.

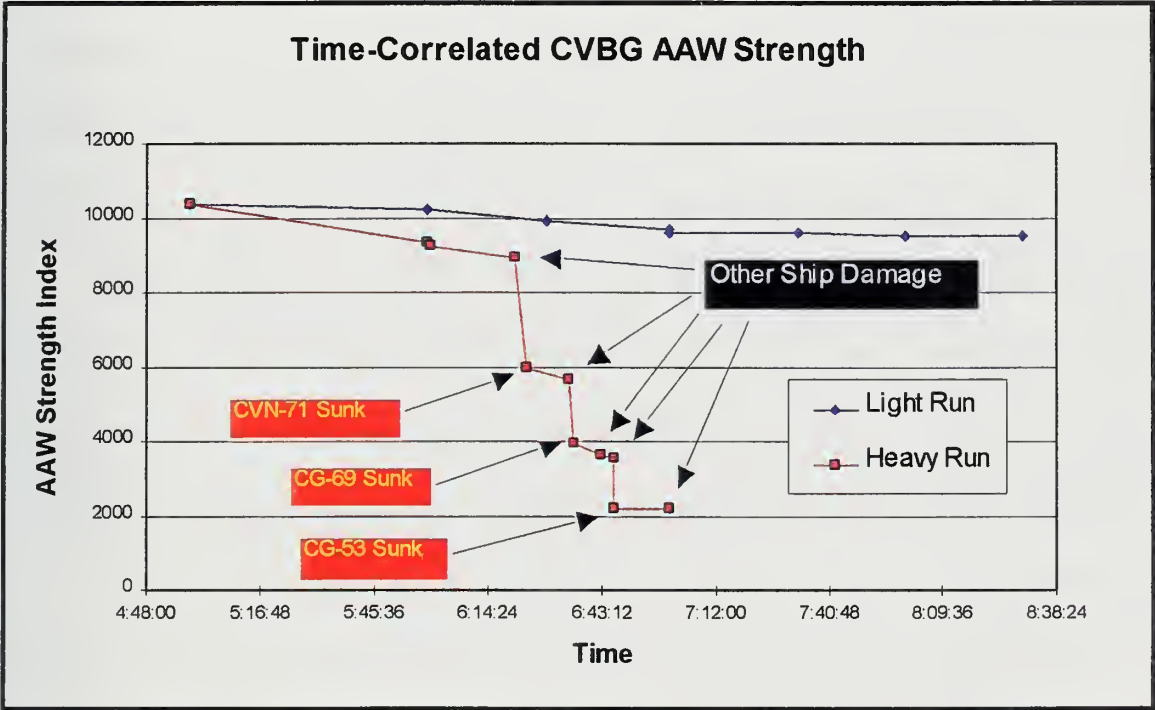
### **1. Sorting.**

The ultimate goal of the data manipulation was the production of graphs allowing comparisons of the CVBG AAW performance in each of the two scenarios. Creation of the graphs required several iterations of data sorting routines of the output files. These sorting routines predominantly involved the elimination of units which did not contribute in the AAW defense of the CVBG and the reduction of redundant entries in the data files. Most importantly, files were sorted by unit to facilitate the removal of non-AAW platforms and by time to maintain the chronological order of events. In the case of the

engagement file, an additional sort routine was employed to group engagement types, which were then sorted chronologically within their respective categories. The sorted engagement output from the *heavy* scenario is provided for reference in Appendix C.

**2. Time Correlated Strength Measure.**

The AAW strength of the CVBG, as previously described, provides a measure of the battlegroup’s AAW capability over time. The initial index value is the sum of all products of CVBG assets and their AAW strength factor. Figure 12 provides the strength



**Figure 12. Time-Correlated AAW Strength Measure.**

measures for both the *heavy* and *light* runs and quantitatively shows the stark contrast between the two outcomes.



In the *heavy* run, the initial degradation (5:59) is a result of the initiation of conflict, during which the Iranian surface patrol craft shot down the CAP aircraft. While it is clear that the coordinated raids in the *heavy* run were designed to impact the CVBG predominantly between 6:45 and 7:00, the critical damage can be more specifically analyzed on an individual asset basis. Primarily, in this scenario, each of the three AAW HVUs (CVN, 2 CGs) were destroyed, resulting in the loss of nearly 80 per cent of the total AAW capability of the CVBG.

The carrier was subjected to only two waves of missile attacks, with the second wave, occurring at 6:24, providing the final destructive blow. With the destruction of the carrier also comes the removal of her air wing, which was able to fly off prior to the sinking of the ship. Regardless, the wing was now unable to provide CAP or DCA aircraft, thereby weakening the overall CVBG strength proportionally.

By 6:46, both cruisers were destroyed, with the first sunk at 6:36. Each was able to sustain an initial wave of missile and aircraft attacks with moderate damage but could not defend against subsequent raids after sustaining damage initially. In JTLS, a Weibull Distribution is used to determine the number of hits needed to sink naval units. [Ref 22]

The data from the *light* run, also displayed in Figure 12, shows the CVBG strength when the CAP aircraft are not shot down at the initiation of hostilities and are free to intercept the inbound raids prior to their weapons release. There is no significant damage to any surface asset in this case, due in large part to the execution of the defense-in-depth concept. Simply stated, it is easier for the surface platforms to engage the “leakers” that get through the CAP and DCA aircraft than it is to defend against the numerous missiles





launched by the raids when they are unopposed. In this case, the minute degradation in AAW strength over the course of four hours is the result of individual aircraft being shot down in air-to-air combat, thus reducing the squadron strength of the air wing.

Figure 13 provides a graphical representation of the CVBG’s ability to execute defense-in-depth. Regrettably, the engagement data are only available for aircraft at this writing and not missile engagements; however, future versions of the output code may include the engagement range data for missiles as well as aircraft. The *light*

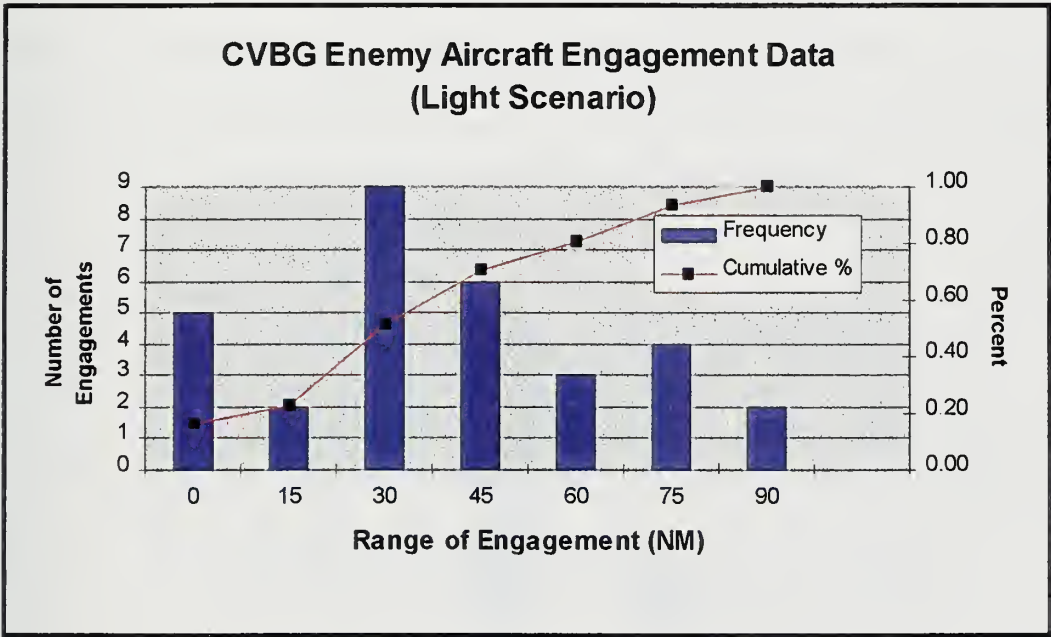


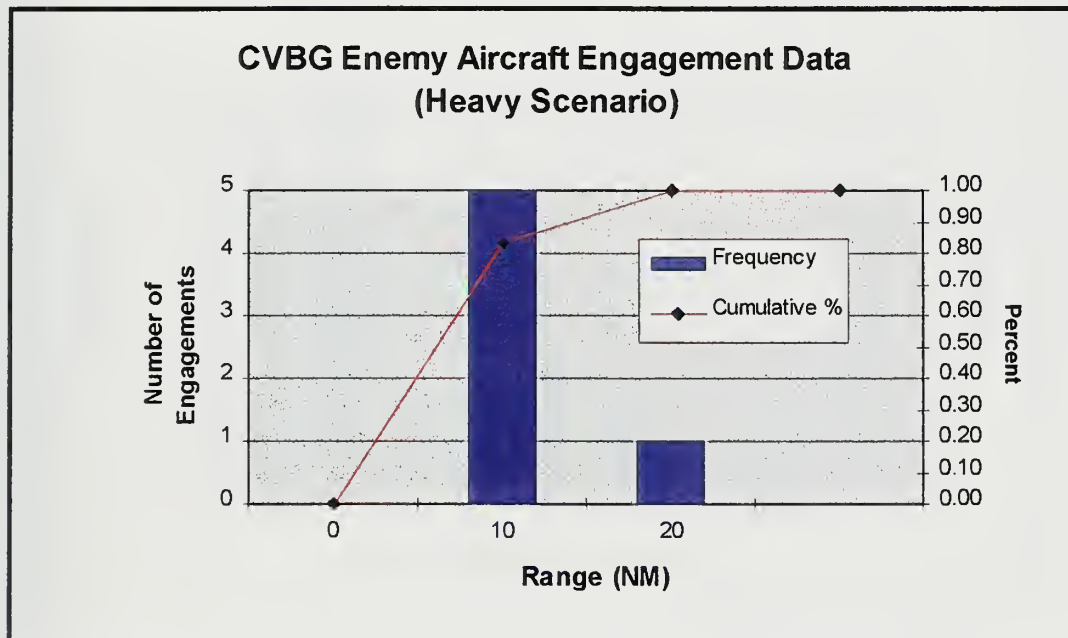
Figure 13. CVBG Enemy Aircraft Engagement Data For Light Scenario.

scenario is examined first in this case because it provides the most useful data to demonstrate the methodology. Of particular interest is that nearly 80 per cent of all aircraft engagements occur at 15NM or greater, with 50 per cent at 30NM or greater. Because 15NM is outside of the weapons range of the basic point defense systems, whose



maximum effective range is modeled at a generous 10NM, this may be an indication that the defense-in-depth tactic has achieved some degree of success.

Additionally, approximately 20 per cent of the total engagements were conducted at long range by CAP. Is 80 per cent of the engagements conducted by sources other than point defense systems sufficient? That is an issue for the CINC to determine, but now he may do so *quantitatively*, based upon the model output. Equally interesting is the fact that the remaining 20 per cent of engagements are conducted by point defense systems – whose reliability is often questioned. In this case, the point defense system kills 80 per cent (four of five) of the inbound targets. Figure 14 provides the same data for the *heavy* scenario,



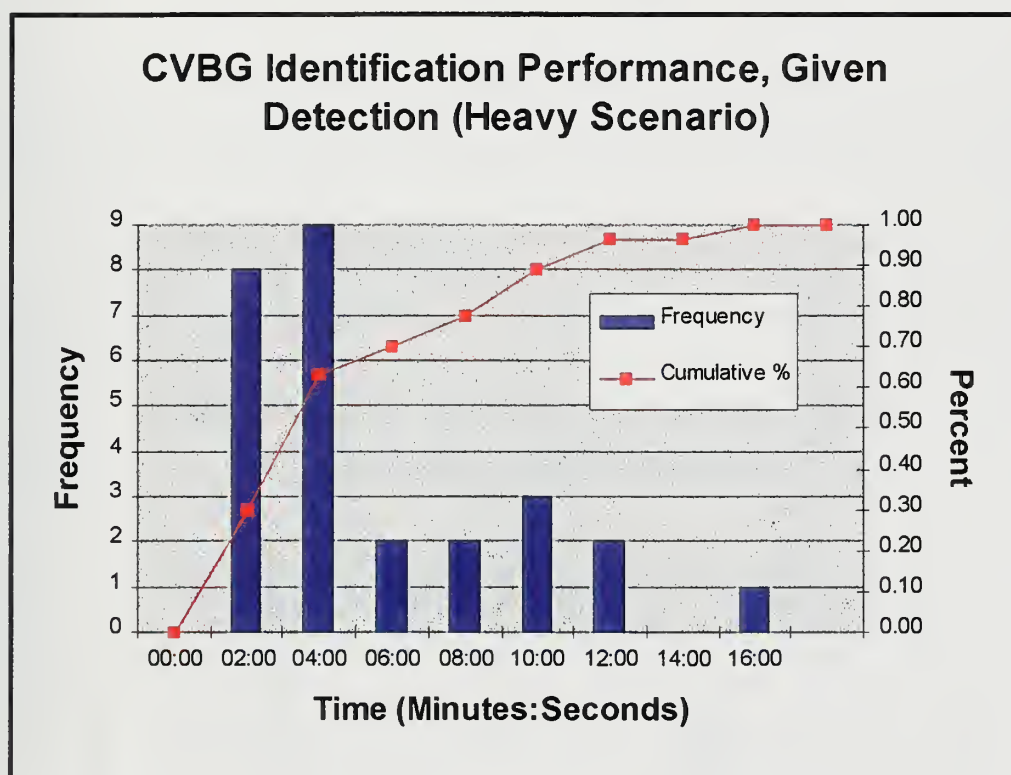
**Figure 14. CVBG Enemy Aircraft Engagement Data For Saturation Scenario.**

though all engagements in this case are SAM engagements due to the initial loss of the CAP aircraft. The greatest value of this graph is that of determining, due to the



paucity of aircraft engagements, that a concentration of effort was expended *not* on engaging aircraft, but instead on engaging missiles. This serves as an immediate flag to the breakdown of the defense-in-depth concept because the number of aircraft engagements, given the magnitude of the total number of incoming aircraft in this scenario, should be significant. In Figure 14, such is clearly not the case.

Figure 15 displays the identification performance of the CVBG assets against aircraft in the *heavy* scenario. This is a measure of the time differential between detection



**Figure 15. CVBG Identification Performance in Saturation Scenario.**

and *correct* classification as an enemy air asset. While over 60 per cent of the identifications occur in four minutes or less, once again the CINC must determine if that





measure is sufficient to support air warfare in his theater. Again, though missile data would be useful in this case, at this writing data are only available for aircraft contacts, though future plans may include missile data. Should missile data eventually be included into the identification file, it would be fair to assume that far greater numbers would occur at the two minute and less mark. Justification for this lies in the fact that in the littoral, missile flight times of greater than four minutes would be highly unlikely, so the importance of timely classification becomes an issue of utmost urgency. Furthermore, through the use of Electronic Support Measures (ESM), classification of active seeker emissions from missiles will be less difficult and far quicker than the classification of third world aircraft. A sample output from the air detection file is provided in Appendix D.

Figure 16 displays the identification performance of CVBG assets in the *light* scenario. In this case, the performance is nearly consistent with that of the *heavy* scenario

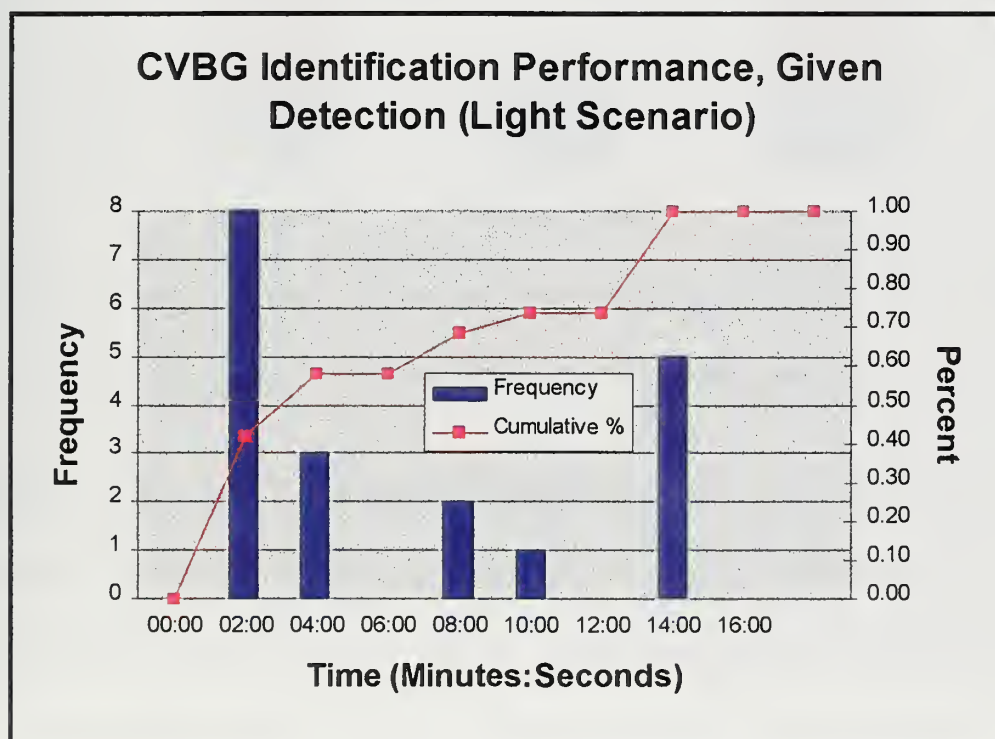
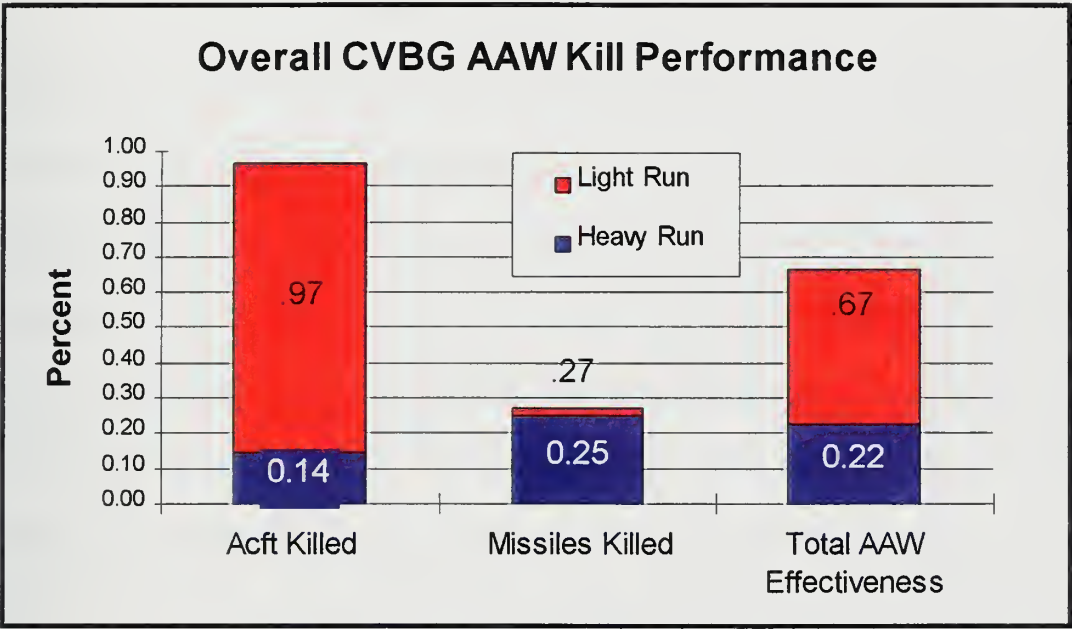


Figure 16. CVBG Identification Performance in Light Scenario.



through the 60th percentile (four minutes), but there is a sharp increase in time required to improve from the 70th to the 100th percentile. The causal factor for time delay was a P-3C which was incorrectly classified – *twice* – and not re-evaluated for several minutes. Once again, the CINC must determine if this is acceptable performance for operations in his theater.

Finally, a measure of overall kill performance for the two scenarios is presented in Figure 17. In this graphical representation, the difference in the quality of identification,



**Figure 17. Overall CVBG AAW Kill Performance.**

engagement and finally, kill performance may be evaluated. In this case, the stark contrast between the overall kill performance of the two runs is directly attributable to the effect of CAP and DCA aircraft in the *light* scenario. Notice that in the *light* scenario, over 96 per cent of all aircraft engaged are killed. In the *heavy* scenario, the corresponding kill



performance is only a meager 14 per cent. This stems in part from the fact that the initial wave of missile and air attacks in the *heavy* scenario partially degraded the AAW HVUs capability to wage war. Specifically, recall Figure 12, which shows the damage to the AAW HVUs in the AAW strength representation. The numbers of attackers are compiled through examination of both the engagement file and the air mission file, which lists all enemy air attack missions as well as all CAP and DCA missions. A sample air mission file output for the *heavy* run is provided in Appendix E. Despite the fact that the performance of the CVBG against the missile threat was fairly consistent throughout both scenarios, the impact of the aircraft kill performance dramatically improves the overall AAW kill performance in the case of the *light* scenario. However, when all enemy air threats are investigated, the CINC will have difficulty justifying how his *best* air team's kill performance is only 66 per cent - that is akin to saying that one of three members will die in the *best* case. Why was there less than 100 per cent effectiveness in a scenario during which no surface ships were damaged by missiles or aircraft, such as the *light* run? Simply stated, in the instances where the CVBG failed to kill the threat, in this case he was fortunate. The area weapons (SCUD) were ineffective and inaccurate, and the cruise missiles remaining did not reach their target successfully.

## C. CONCLUSIONS

The use of this methodology to examine CVBG AAW capability appears to validate the utility of CAP aircraft and shows an inability of surface forces to adequately

counter a missile threat. More importantly, however, this chapter has demonstrated a methodology by which force protection (in this case the anti-air warfare protection capability of a carrier battlegroup) can be evaluated in post exercise analysis. In addition, the methodology illustrates the potential for force AAW improvement through the optimal use of all CVBG air assets. Viewed exclusively, this analysis does not pinpoint *specific* weaknesses in an AAW campaign (*why* was the missile defense inadequate?), though when viewed as a subset of the overall air picture (including strike, ASW, AEW, recce and other air missions), it may be possible to improve the performance of the air team.

Additionally, it demonstrates a vehicle for determining a causal audit trail of events culminating with the loss, in the case of the *heavy* scenario, of nearly 80 per cent of the total AAW capability of the battlegroup. In this respect, the performance of the force regarding joint Strategic Task 6 (Provide Theater Protection) was affected by the performance of specific tasks involving Operational Task 3 (Provide Operational Firepower) and Tactical Task 3 (Employ Firepower). In the case of the poor performance against cruise missiles, data can be collected from similar dendritic and flow charts which will allow future analysts to focus exclusively on reasons pertinent to missile defense. Aside from low kill probability, is the performance a results of technological difficulties, radar anomalies, reaction time deficiencies or perhaps the result of magazine size inadequacies? Future analysis may answer these questions through the application of this methodology.



## VI. CONCLUSIONS AND RECOMMENDATIONS

The more you sweat in peace, the less you bleed in war *Chinese Proverb*

### A. CONCLUSIONS

While this research focused on the methodology necessary to evaluate CVBG AAW capability in a CAX, the principles of the methodology are applicable to the entire spectrum of UJTL tasks. The methodology is not intended to assess execution of joint tasks. Its focus is on evaluating process performance that ultimately is used to provide insight to significant events observed during the exercise. The methodology is comprised of two significant elements. The first is the determination of MOPs and MOEs necessary for evaluation of the appropriate CINC's exercise training tasks, and ultimately, data collection. The second is the development of the procedures necessary for the data extraction to simulation output files for manipulation into user-friendly, objective, after-action review.

There are several strengths of the proposed methodology over the existing post process evaluations. Primarily, the method is uncomplicated, yet robust enough to be applicable to a variety of warfare areas, regardless of the particular scenario. Accordingly, it naturally lends itself to quick analysis that can be easily grasped by all members of the CINC's staff. Secondly, to produce the data necessary for evaluation does not require any outside action by the staffs under evaluation, nor does it require excess "training cell" members who may inadvertently confound the smooth running of the game and interfere with the staff's execution of campaign strategies. By automating the order inputs and

creating precise output file code, the necessary data are immediately and unobtrusively collected in post processor files for later review upon game completion.

Thirdly, by using measures of performance and effectiveness defined prior to the scenario, an analyst may capture precisely the data necessary to present a completely objective, statistically sound data set representing the performance of those being evaluated. With moderate effort, that data set may be converted into a graphical representation of the performance that even non-analysts can easily understand.

Care must also be taken by CINC's to understand the limitations associated with modeling and simulation. Recall that each simulation represents one possible outcome based upon randomness introduced through several seeds in the database. In this respect, the results, either fair or poor, may *not* actually reflect the capabilities of his staff under certain circumstances, but instead may simply be a measure of kill probabilities or logistical readings.

An extremely powerful tool, JTLS is capable of representing virtually all significant functions relevant to military operations into its inherent procedures and data structures. Although some functions lack the desired degree of fidelity, the exercise planner should assume, in the interest of process analysis, that the model is capable of adequately representing essential elements of the staff's plan and producing data beneficial to post-exercise analysis.

## B. RECOMMENDATIONS

Continued effort should be directed towards methodology refinement for more expeditious post-processing analysis. Post-processing requirements for this thesis involved two aspects. The first required the determination of needed information and the appropriate method to develop the algorithms for capturing and writing result to an output file. The second aspect, primarily data manipulation, involved operations performed on the output file in preparation for the presentation of results. Considering the scale of the exercise data base and the force sizes under analysis, the operations required a considerable amount of time and would not be conducive to large-scale analysis. Better use of the features inherent in the model's post processor may substantially reduce analysis time in future analysis, though this requires precise determination of data requirements during exercise planning and design.

With respect to the evaluation of joint AAW in theater level simulations, several additional topics of interest may be reviewed in future simulations which were not factors in these simulations. First, the effect of Rules of Engagement (ROE) on warfare may have a significant impact on both the tactical and operational level in future OOTW and LIC scenarios. An examination of theater force protection involving challenging ROE, similar to actual ROE according to CINC-specific doctrine, may provide noteworthy results.

The utility of CAP aircraft on a maritime AAW scenario was demonstrated in these scenarios, but the specific examination of CVN deck loading in the event of carrier battle damage and ordinary flex-deck operations may also provide interesting limitations to our

current capabilities. To those who claim that such analysis is inappropriate in a theater level simulation, recall that a carrier and its air wing are a significant theater asset whose employment greatly impacts the outcome of battle in the AOR.

Future analysis may gain additional credibility for AAW analysis by incorporating raid size into the total AAW capability. In the case of this thesis, the CVBG performance was evaluated in terms of a *kill* measure. A more thorough future evaluation may include the difficulty, perhaps identifying performance against *specific* enemy systems, associated with the overall inbound threat. In this thesis the CVBG performed poorly against the larger raid, but adequately met the threat in the *light* scenario. Perhaps future analysis may incorporate a scaling factor predicated on the total raid size or the concentration. In this manner, the scaling factor may be a derivative based on threat per time.

JTLS assumes that all forces operating on the same side have access to electronic data (data links) from all sensors, regardless of service. While this is ultimately the goal of the U.S. military forces, it is seldom easy or *possible* to gain or maintain a flawless link with joint forces. That this is not incorporated into the model actually serves to bring the forces closer to perfect intelligence than they may actually be. Perhaps some joint connectivity difficulties should be incorporated into the model. Similarly, no conflicts between USN and USAF intercepts are modeled in JTLS – in the model, the closest available asset responds to enemy air missions, while in an actual theater, politics plays as large a part in the decision-making process as the tactical implications.

## APPENDIX A. AAW STRENGTH FACTORS FOR CVBG ASSETS

The following matrix represents the AAW strength factors used to calculate the CVBG overall AAW strength index. The strength factor is similar to a firepower score for a specific mission (in this case, AAW) when applied as a product with the individual asset strength value. For this scenario, the aircraft carrier and Aegis cruisers are not only HVUs, but are clearly the most heavily weighted AAW assets. To examine other mission (ASW, ASUW, etc.) strengths over time, similar matrices may be derived and applied in the same manner.

Asset	AAW Factor
AE-29	1
AOR-7	1
CG-53	20
CG-69	20
CVN-71	40
DD-966	1
DD-982	1
FFG-38	5
FFG-59	5
VF-154	5
VF-84	5





## APPENDIX B. STRENGTH FILE POST PROCESSOR OUTPUT

A representative sample of the strength file in both its raw and sorted forms for the *heavy* run are provided in this appendix. Rolands and Associates, Inc. ensured that the output, in ASCII format, was formulated to allow the user to quickly and seamlessly manipulate the data in a commercial spreadsheet. The output provided here, and in all other appendices, is the result of an Excel spreadsheet manipulation.

Raw output sample from Strength File:

Game Time	Unit Type	Unit	Strength
3:00:01	1	4SUPPLYCO	694.66
3:00:01	1	4SUPPLYCO	99.76
5:38:24	1	THIRDARMY	99.8
5:45:36	1	3ARMY.ASG	99.78
5:45:36	1	101DISCOM	99.81
5:59:07	1	CVN-71	73.91
6:00:00	1	VF-84	81.74
6:20:54	1	CG-53	83.33
6:24:07	1	CVN-71	0
6:34:43	1	CG-69	83.33
6:36:05	3	MR2-3	50
6:36:05	3	SS8	50
6:36:05	3	MR2-3	0
6:36:05	3	SS8	0
6:36:05	3	RADAR10	0
6:36:05	3	HARP-8	50
6:36:05	1	CG-69	0
0.2795958	1	CG-53	66.67
0.282061	3	PHALANX4	0
0.282061	3	SS4	0
0.282061	3	RADAR4	0
0.282061	3	SPS55-5	0
0.282061	3	HARP-4	0
0.282061	3	TORP5	0
0.282061	1	DD-966	0
0.2821637	1	CG-53	0
0.2832108	3	HARP-4	3.12
0.2836528	3	HARP-4	6.25
0.2842138	3	HARP-4	9.38
0.287062	3	HARP-4	12.5
0.2902991	3	HARP-4	15.62
0.291669	1	FITRON.IR	98.38
0.291669	1	FARON2.IR	98.38
0.291669	1	D-24DISCO	100
0.2924618	3	HARP-4	18.75
0.2968849	3	HARP-4	21.88
0.2971954	3	TORP5	100

Sorted output from Strength File:

Game Time	Unit Type	Unit	Strength
5:59:07		1 CVN-71	73.91
6:00:00		1 VF-84	81.74
6:20:54		1 CG-53	83.33
6:24:07		1 CVN-71	0
6:34:43		1 CG-69	83.33
6:36:05		1 CG-69	0
6:42:37		1 CG-53	66.67
6:46:10		1 DD-966	0
6:46:19		1 CG-53	0



## APPENDIX C. ENGAGEMENT FILE POST-PROCESSOR OUTPUT

The output from the Engagement File is perhaps the crux of this thesis. Using these data, it is possible to determine the kill-to-engagement ratio and to evaluate kill performance against specific threat types. Additionally, further analysis on the efficiency of kills (for example, number of missiles fired per kill) or other MOEs may be evaluated from these data. A sample sorted output is provided.



Blue Engagements	Shooter	Weapon	#	Target	Victim	Target Name	#	Pk	Range
6:26:09 ada_vs_ac	SS9	SEASPAR	2	ATTACK	BF11-280011	F1	Kill	0.1811	10
6:27:34 ada_vs_ac	MR2-4	RIM.66	2	ATTACK	BFISH1-280008	FISHBEDJ	1	0.2420	16.95
6:37:17 ada_vs_ac	MR2-6	RIM.66	2	ATTACK	BFISH2-280009	FISHBEDJ	0	0.1821	10
6:45:14 ada_vs_ac	SS9	SEASPAR	2	ATTACK	BF13-280013	F1	0	0.1811	10
6:45:58 ada_vs_ac	SS7	SEASPAR	2	ATTACK	STU163-280004	TU16-G	0	0.1812	10
6:46:10 ada_vs_ac	SS4	SEASPAR	2	ATTACK	BFISH3-280010	FISHBEDJ	0	0.1811	10
5:59:07 ada_vs_ssm	SS1	SEASPAR	5	SSM	IRAN	HARP_AIR	1	0.25	
6:24:07 ada_vs_ssm	PHALANX1	VULCAN	25	SSM	IRAN	HARP_AIR	3	0.25	
6:24:07 ada_vs_ssm	SS1	SEASPAR	2	SSM	IRAN	HARP_AIR	0	0.25	
7:20:49 ada_vs_ssm	MR2-6	RIM.66	2	SSM	IRAN	SCUD	1	0.35	
8:10:49 ada_vs_ssm	MR2-6	RIM.66	1	SSM	IRAN	SCUD	1	0.35	
8:26:19 ada_vs_ssm	MR2-4	RIM.66	2	SSM	IRAN	SS-N-19	0	0.35	
6:26:19 ada_vs_ssm	SS9	SEASPAR	2	SSM	IRAN	SS-N-19	0	0.25	
6:46:19 ada_vs_ssm	SS9	SEASPAR	2	SSM	IRAN	SS-N-19	1	0.25	
6:46:19 ada_vs_ssm	SS9	SEASPAR	0	SSM	IRAN	SS-N-19	0	0.25	
8:21:32 ada_vs_ssm	MR2-3	RIM.66	2	SSM	IRAN	SS-N-22	1	0.35	
6:21:32 ada_vs_ssm	MR2-3	RIM.66	1	SSM	IRAN	SS-N-22	1	0.35	
6:21:32 ada_vs_ssm	SS8	SEASPAR	1	SSM	IRAN	SS-N-22	1	0.25	
6:21:32 ada_vs_ssm	MR2-3	RIM.66	0	SSM	IRAN	SS-N-22	0	0.35	
6:21:32 ada_vs_ssm	SS8	SEASPAR	1	SSM	IRAN	SS-N-22	1	0.25	

Aircraft Attack

Air to Surface Cruise Missiles

Surface to Surface Cruise Missiles



## APPENDIX D. AIR MISSION DETECTION FILE OUTPUT

The following represents a sample output of the Air Mission Detection File, which provides data necessary for the evaluation of detection, identification and classification of air contacts.

Game Time	Detector Side	Mission Name	Detection	Track Number	Track Side
5:42:05	UN.FORCES	P3C1-280016	BL.LR.AIR	FIRST_TIME	Unknown
5:51:31	UN.FORCES	P3C1-280016	BL.LR.AIR	BA0006	IRAN
5:54:03	UN.FORCES	P3C1-280016	Unknown	BA0006	IRAN
5:59:07	UN.FORCES	P3C1-280016	BL.LR.AIR	BA0006	IRAN
6:06:16	UN.FORCES	S27D1-280000	BL.LR.AIR	FIRST_TIME	Unknown
6:07:05	UN.FORCES	P3C2-280017	BL.LR.AIR	FIRST_TIME	Unknown
6:10:13	UN.FORCES	STU161-280002	BL.LR.AIR	FIRST_TIME	Unknown
6:10:39	UN.FORCES	S27D1-280000	BL.LR.AIR	BA0008	IRAN
6:11:27	UN.FORCES	STU161-280002	Unknown	BA0010	IRAN
6:12:40	UN.FORCES	STU161-280002	Unknown	BA0010	IRAN
6:13:53	UN.FORCES	STU161-280002	Unknown	BA0010	IRAN
6:13:56	UN.FORCES	S27D1-280000	BL.LR.AIR	BA0008	IRAN
6:14:18	UN.FORCES	P3C1-280016	BL.LR.AIR	FIRST_TIME	Unknown
6:14:57	UN.FORCES	BF11-280011	BL.LR.AIR	FIRST_TIME	Unknown
6:15:02	UN.FORCES	S27D1-280000	GCI.RADAR	BA0008	IRAN
6:15:07	UN.FORCES	STU161-280002	Unknown	BA0010	IRAN
6:15:50	UN.FORCES	S27D1-280000	GCI.RADAR	BA0008	IRAN
6:16:00	UN.FORCES	STU161-280002	Unknown	BA0010	IRAN
6:16:51	UN.FORCES	BF11-280011	BL.LR.AIR	BA0012	IRAN
6:17:14	UN.FORCES	STU161-280002	Unknown	BA0010	IRAN
6:18:02	UN.FORCES	S27D1-280000	GCI.RADAR	BA0008	IRAN
6:18:27	UN.FORCES	STU161-280002	Unknown	BA0010	IRAN
6:19:03	UN.FORCES	BF11-280011	BL.LR.AIR	BA0012	IRAN
6:19:17	UN.FORCES	BFISH2-280009	BL.LR.AIR	FIRST_TIME	Unknown
6:19:40	UN.FORCES	STU161-280002	Unknown	BA0010	IRAN
6:19:51	UN.FORCES	BF11-280011	BL.LR.AIR	BA0012	IRAN
6:19:57	UN.FORCES	BFISH1-280008	BL.LR.AIR	FIRST_TIME	Unknown
6:20:14	UN.FORCES	S27D1-280000	GCI.RADAR	BA0008	IRAN

## APPENDIX E. AIR MISSION FILE

The Air Mission File documents the assignment and status of all air missions that are executed during the course of the JTLS scenario. The following is a sample output from the *heavy* run.

Game Time	Mission Name	Type	Acft Type	Weapons Load	Target
3:30:00	AW1-280018	AWACS	E2C	NO_LOAD_YET	NONE
3:30:00	CAP1-280019	CAP	F14	NO_LOAD_YET	NONE
3:30:00	CAP2-280020	CAP	F14	NO_LOAD_YET	NONE
3:30:00	AW1-280018	AWACS	E2C	E2C.S1	NONE
3:30:00	REF1-280021	REFUEL	KC135	NO_LOAD_YET	NONE
3:30:00	REF1-280021	REFUEL	KC135	KC135.L1	NONE
4:29:59	P3C1-280016	ATTACK	P3C	P3C.ASM	CVN-71
4:54:59	P3C2-280017	ATTACK	P3C	P3C.ASM	CVN-71
5:37:27	CAP1-280019	CAP	F14	F14.WL1	NONE
5:37:42	CAP2-280020	CAP	F14	F14.WL1	NONE
5:45:00	CAP3-280022	CAP	F14	NO_LOAD_YET	NONE
5:45:00	CAP3-280022	CAP	F14	F14.WL1	NONE
5:53:27	STU161-280002	ATTACK	TU16-G	TU16.WL1	CG-53
5:55:36	S27D1-280000	ATTACK	MIG27-D	MG27.WL1	CVN-71
6:06:11	BFISH1-280008	ATTACK	FISHBEDJ	M21J.WL4	CVN-71
6:06:28	BF11-280011	ATTACK	F1	F1.AG	CG-53
6:08:47	STU162-280003	ATTACK	TU16-G	TU16.WL1	CG-69
6:09:35	S27D2-280001	ATTACK	MIG27-D	MG27.WL1	CVN-71
6:16:40	STU163-280004	ATTACK	TU16-G	TU16.WL4	CVN-71
6:17:02	BFISH2-280009	ATTACK	FISHBEDJ	M21J.WL4	FFG-59
6:18:36	BF12-280012	ATTACK	F1	F1.AG	CG-69
6:19:20	S27D3-280006	ATTACK	MIG27-D	MG27.WL1	CG-53
6:23:27	STU164-280005	ATTACK	TU16-G	TU16.WL4	CG-53
6:25:36	S27D4-280007	ATTACK	MIG27-D	MG27.WL1	CVN-71
6:26:06	BF13-280013	ATTACK	F1	F1.AG	CVN-71
6:26:10	BFISH3-280010	ATTACK	FISHBEDJ	M21J.WL2	DD-966
6:36:11	BFISH4-280015	ATTACK	FISHBEDJ	M21J.WL3	CVN-71
6:36:28	BF14-280014	ATTACK	F1	F1.AG	CG-53

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